POWER

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If We All Do Our Part

AMONG the many Christmas and New Year greetings that came to me was one that expressed a hope for progress and prosperity in the coming year and the belief of the sender that they would come "if we all do our part."

There is on the part of many of us a, perhaps natural, tendency to let down. To some this comes occasionally as a reaction against the tedium and fatigue of sustained application. To others it is a normal condition through laziness, lack of interest, the disposition to give as little as possible for what they get, to make the job last, bravado before comrades, or discontent.

All sorts of devices have been employed to overcome this disposition and to encourage each to do faithfully his part; piecework, premiums, bonuses, demonstration of the reacting benefits of efficiency. A friend sends me this story of how a provoking manifestation of this letting-down was overcome.

It was late in the fall, several years ago, when an unexpected and severe drop in temperature left a number of Great Lakes freighters, which took a chance on that proverbial last trip, stuck in the ice.

A retired chief engineer was drafted for this last trip of one of the boats. His lack of punch was soon sensed by the firemen and coal passers, and the steam went down so that the vessel was unable to effectively buck the ice and make headway.

When a young and energetic assistant engineer was on watch the fire gang tried the same tactics and the situation distressed and humiliated the young executive.

His admonitions brought forth the same old array of time-worn alibis, dirty coal, boiler scale, poor draft, etc., ignoring entirely the individual's responsibility in the performance of the vessel.

Presently, when the engine was barely turning over the young engineer stepped unexpectedly into the firehold and addressed the ringleader with the curt inquiry: "What is your name?"

"O'Brien," was the answer.

The assistant engineer, himself of Irish descent, acted grieved and reluctant to believe it, but advised the fireman, if it were a fact, to go to the nearest courthouse upon setting foot on land and have his name changed, for no man with the name of O'Brien would ever be so yellow as to shirk under such circumstances.

The engineer turned and left the hold. In a short time the engine began to speed up and the vessel to make satisfactory progress, while occasional pops of the safety valve showed the new spirit which had taken hold in the firehold and which lasted until the freighter was made fast to the dock.

F. R. Low

EDITORIALS

Coal's Outlook Not All Black

SOME OF the statistics for 1930 paint a gloomy picture for coal, while in their next breath they reiterate the fact that coal will continue to be the principal fuel for the production of light, heat and power.

It is said that there has been a decrease of sixty-four million tons in the consumption of 1930 compared with the year previous and that natural gas and fuel oil are a growing competitive menace.

Granting the verity of these bare statements, the situation is really not so drear nor nearly so hopeless when fully considered; provided the coal men take cognizance of and benefit by hitherto little considered aspects of their case.

Everyone knows that, by and large, 1930 was a poor year industrially. Yet bituminous production was off less than 13.2 per cent and anthracite less than 4.2 per cent, compared to a similar period in 1929.

There is a marked increase in output from large coal mines and a corresponding decrease in both the number and output of smaller ones. This is evident recognition of the advantages of large-scale operation and the production benefits from the increasing use of machinery above and below ground.

Perhaps one reason why natural gas is being used for boiler fuel, where it is economically available, is its cleanliness and freedom from smoke, cinder and fly ash. Power producers are everywhere becoming more concerned with these desiderata and will inevitably recognize their cash value. An awakening public is commencing to press for smoke abatement, flue dust elimination and the like, and wise power producers are answering by renewed efforts to minimize these objections.

Here lies a great opportunity for forward-looking coal producers. They should view most of the power plants burning natural gas under their boilers as potential coal consumers, for, excepting in a few localities, gas supply contracts are being made subject to termination at the option of the vendor and will be continued only so long as the supply exceeds the demand at more lucrative rates.

Eventually a large portion of this market should come back to coal burning.

In the meantime a greatly improved market already awaits enterprising producers who will seriously study the combustion requirements for industrial, public utility and even domestic consumption, and arrange to furnish a uniformly graded standard of quality to meet the rapidly growing demand for a cleaner atmosphere.

Are Refrigerating Methods Antiquated?

RECENT ACTIVITY in the application of refrigeration to numerous industrial processes, has introduced new arrangements of freezing machinery and even new designs. In spite of this, the basic method of manufacturing ice remains as it has been since the adoption of the brine-submerged ice-freezing can—an attempt to copy Nature's process, and Nature is never worried by time. Consequently, the method is open to examination, if not to challenge.

The time for the transfer of heat from the water to the brine varies with the square of the thickness of the ice film on the can surface. Every refrigerating engineer has observed the rapidity with which the first inch of ice forms, and the gradual slowing up of the process as the ice thickens, until the freezing of the core seems to take eons. In fact one must be something of a philosopher to operate a freezing tank without a mental breakdown.

If ice must be marketed in the form of a cake eleven inches thick probably nothing can be done about it; but why such a cake?

Why should not ice be supplied in sheets of two-inch thickness, and the total pounds needed for an ice box

obtained by stocking a series of sheets? Freezing time would be reduced to an astonishing degree, which would reduce the size of the tank for a desired capacity. Furthermore, it would be quite possible to build up a cake to any thickness by piling the sheets and then freezing slightly. The thin sheet would have the advantage of enabling the housewife to obtain those cute little ice cubes which have sold so many mechanical ice boxes.

After all, the home is gradually losing its position as a major market for ice, and in the future other users will be found, such as building, air conditioning and commercial ice boxes. In such applications there is no need for a thick ice cake.

Granted that a thin cake or sheet is a commercial possibility, the next query of the refrigerating industry may well be: "Why use brine as an intermediary?"

Why should ice not be frozen in trays in whose walls are passages for the ammonia to flow? If high back pressures mean economy, then the reduced temperature difference resulting from the elimination of the brine should make the direct-freezing method worth while.

Another St. Lawrence Report

THE ENGINEERING board appointed by the St. Lawrence Power Development Commission of New York State has recently made its report. This report deals only with the engineering phase of the project. It differs from previous engineering reports in that it recommends a new site for a single-stage power project in the international section of the river and that the development be made in two steps. The first would consist of a dam partly completed to back up approximately fifty feet head of water and a power plant to provide six hundred thousand horsepower. In the second step the dam would be raised to give full head at the plant and the power plant extended to provide over two million horsepower.

Canadian advocates of a two-stage development plan have always based their arguments upon the lower initial development cost and the smaller land area flooded by the required water storage. The new proposal for a single project constructed in two steps apparently has the lower initial cost advantage of a two-stage development. However, it would flood practically the same land area as the other single-stage projects proposed; the area flooded by a single development being about five times that required for a two-stage project.

This is one of the most serious objections raised by the Canadian engineers against a single-head project, and up to this time there is little indication that they have changed.

The lower ultimate cost of a single development is a major advantage. The saving varies from fifty to seventy million dollars, depending upon what is included in the project. Whatever the arguments against land flooding in a single-stage project, a reduction in cost of fifty million dollars will be hard to cast aside.

If the board should succeed in settling the engineering differences involved in the development of the international section of the St. Lawrence, numerous other problems, many of which are outside the jurisdiction of the state of New York, would also have to be solved before work could actually start.

Pulverized-Coal-Ash Disposal

PROFITABLE DISPOSITION of ash and of refrigeration to numerous industrial problem that is far from settled despite numerous attempts at its solution. Investigations now going on include its possible use as a dilutent for commercial fertilizer, as a road surfacing material, and, if iron oxide be absent, as an ingredient in building blocks and artificial stone. Experiments are also being made to reclaim metallic constituents, such as aluminum oxide, through the reduction of the ash. These proposals have possibilities, but as yet little is known of their commercial values.

There are undoubtedly many uses to which fly ash could be put, but few would require sufficient quantities to prove attractive. Moreover, such ash is handicapped in its transportation, and few power plant managements are in a position, or willing, to assume the added burdens of a byproduct industry.

Meanwhile, the number of pulverized-coal installations is increasing. Reliable estimates place the present quantity of recoverable ash and slag in the United States at nearly a million tons yearly. While the earlier practice of sluicing to fills is being followed by those plants favorably situated, many new plants are being located where the ash cannot be disposed of in that way. Also, greater recovery of fly ash is indicated as a result of public demands for less atmospheric pollution.

Thus the problem looms larger and its successful solution holds increasing interest. So far the burden of disposal has rested with power plant men. Opportunity awaits some enterprising minds in industry to convert this substance into a profitable raw material.

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POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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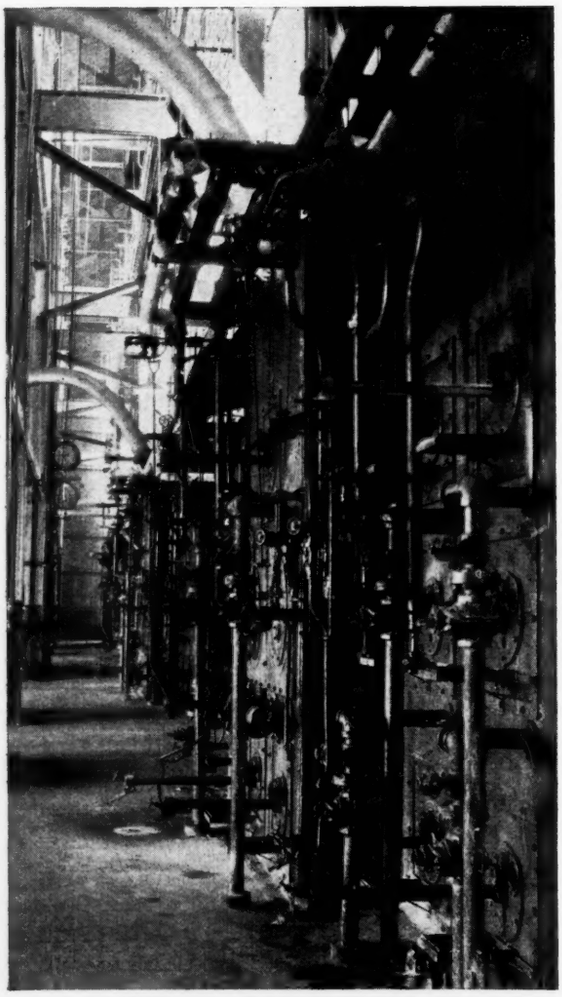
Refinery Waste Supplements



View of boiler fronts, showing burners

Neutralized sludge, wax tailings, soda bottoms and pulverized refinery coke are burned in combination with fuel oil or natural gas under the four boilers at the plant of the Louisiana Steam Products, Inc. Each boiler is equipped to burn as many as four different kinds of fuel at one time

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UNMARKETABLE byproducts from oil refineries, until the last few years, have been classified as non-combustibles. This classification was accepted despite the fact that the physical characteristics and chemical composition of these waste materials include properties which are essentially combustible and which contain, in various forms, fuels of high heat value. This somewhat illogical situation came about not because the contents of these products were unknown, but because suitable equipment for proper combustion was not available.

While there are a number of different industrial plants producing products and byproducts that may come under this general classification, this article will be devoted to a description of equipment installed in the Louisiana station for the transportation and burning of oil refinery refuse in combination with fuel oil and natural gas.

The Louisiana station of Louisiana Steam Products, Inc.[1], was designed and built by Stone & Webster Engineering Corporation, and is situated on the Mississippi River at Baton Rouge, La., adjacent to the refinery of the Standard Oil Company of Louisiana. It was constructed primarily to supply steam and power to the refinery. Natural gas, from the Monroe field in northern Louisiana, is the base fuel. Auxiliary fuels, representing approximately 50 per cent of total requirements for steam generation, are purchased from the oil company, and consist of all waste fuel products available from the refinery, together with fuel oil which may be required for conditioning the waste fuels or for emergency service in event of interruption of the natural gas supply.

Efficient utilization of miscellaneous oil refinery sludges at this station represents one of the most important developments of the past year in fuel-burning systems. Stone & Webster Engineering Corporation, in co-operation with the Peabody Engineering Corporation, successfully introduced for the first time the mechanical atomization of refinery waste sludges. The economic gain has been at least threefold. Avoidance of steam atomization has not only made possible improved combustion efficiency and prevented a steam loss amounting to several per cent of the total generation, accompanying this method of atomization, but has also made possible a lower moisture content of the flue gases and consequent lowering of the dew point and permitting the attainment of a lower exit gas temperature in the heat-absorption apparatus without risk of corrosion from the acids these gases contain.

Three 15,000-kw. non-condensing turbine-generator units, which operate with steam at 600 lb. throttle

[1]See *Power*, May 27, 1930.

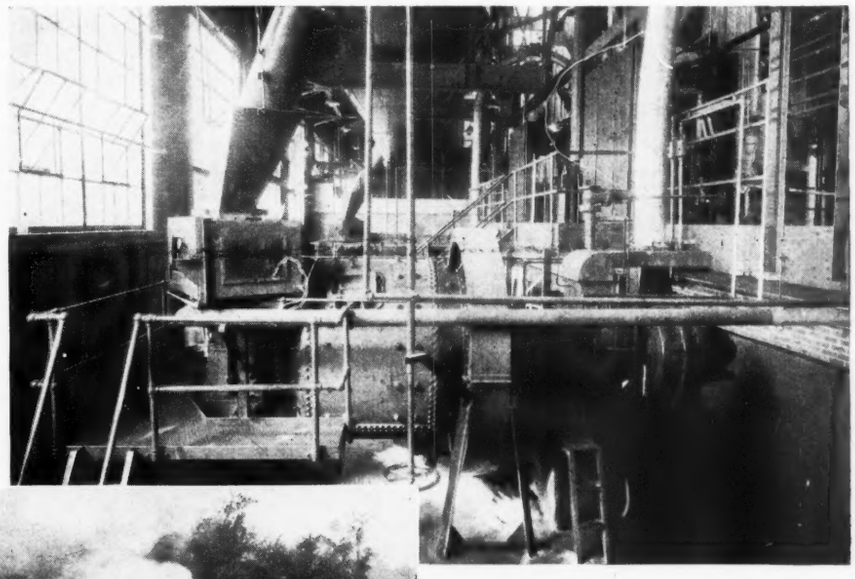
Gas at Louisiana Station

By JAMES F. MUIR
Mechanical Engineer,
Stone & Webster Eng'r'g Corp.

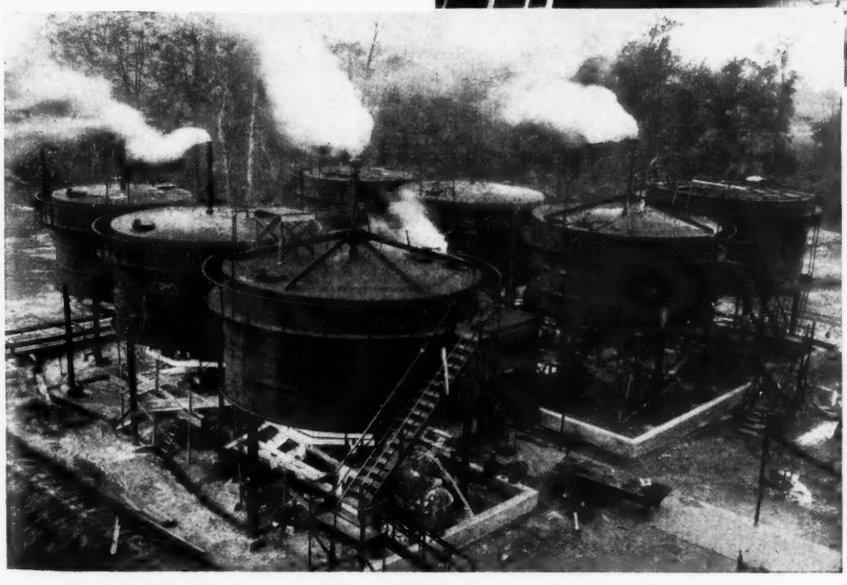
pressure and 735 deg. F. temperature, are arranged to exhaust at 135 lb. gage for oil refinery supply. All surplus power beyond the oil company's requirements will be delivered to the distribution systems of the Baton Rouge Electric Company and the Gulf States Utilities Company. The steam generating units consist of four 13,820-sq.ft. B. & W. boilers, with superheaters, economizers and air preheaters. The side and rear walls and upper portion of the front wall of the furnaces are equipped with Bailey water-cooled walls. The lower half of the front wall in which the burners are located is of solid firebrick construction. Two boilers have seventeen burners each and two eighteen burners each. All the burners are of the combined gas and mechanical atomizing oil type.

Each steam-generating unit has a maximum capacity of 364,000 lb. of steam per hour at 640 lb. pressure, 750 deg. F. total temperature, equivalent to approximately 850 per cent rating on the basis of boiler heating surface and at a heat liberation of about 30,000 B.t.u. per cubic foot of furnace volume.

The Standard Oil Company's Baton Rouge plant manufactures a complete line of refinery products, including lubricating oils and greases. Its operations result in a variety of liquid, semi-liquid and solid byproduct waste fuel. The liquid fuels include neutralized sludge, wax tailings and soda bottoms, all of which are of more or less alkaline composition. The semi-liquids consist of lubricating oil sludge and acid tar, each of which contains a considerable percentage of sulphuric acid. The solid fuel byproducts comprise crude still and cracking oil coke.



Mills for pulverizing coke



Waste-fuel storage tanks are heated by steam coils

Not only has the boiler plant been designed and constructed to burn all of these fuels in combination with fuel oil or natural gas, or both, but each individual boiler is equipped to burn as many as four different fuels simultaneously. This may appear to

be a more or less odd program, but the variety of fuels to be handled and consumed presented an entirely new problem in combustion, and, while the furnace design follows the standard which has been established within the last few years for high rates of combustion and steam generation, it must in this case serve also as a highly efficient incinerator for the disposal of refuse.

The seventeen burners in boilers 1 and 2 are arranged in three horizontal rows, the top row of five consisting of combination fuel oil and gas burners designed for burning natural gas or fuel oil and alkaline waste fuels. Ten burners in the middle and lower rows are designed to burn natural gas, fuel oil and acid tar, and the two remaining burners on each of the boilers are of the Peabody Toronto type, designed for natural gas or pulverized coke. Six of the burners on each of boilers 3 and 4 are designed to burn natural gas, fuel oil and the alkaline fuels, while the remaining twelve burners will burn natural gas, fuel oil and lubricating oil sludge.

During maximum steam demand and with boilers 1, 3 and 4 in operation, the normal distribution of fuels will be approximately as follows:

Boiler 1 will be supplied with 130,000 cu.ft. of natural gas, 20,000 lb. of acid tar and 11,000 lb. of pulverized coke per hour. Boilers 3 and 4 will each consume 14,000 lb. of lubricating sludge, 1,600 lb. of wax tailings or soda bottoms and 325,000 cu.ft. of natural gas per hour.

The characteristics of the alkaline fuels are such that these can conveniently be supplied through the fuel oil lines, which are of steel pipe construction, and any burner arranged for fuel oil combustion can be used, during any operating condition, for either neutralized sludge, wax tailings, or soda bottoms. Lubricating sludge, having a content of dilute sulphuric acid of from 20 to 40% (equivalent to 10 to 20% concentrated acid) and acid tar with a dilute acid content of 40 to 60%, if mixed together or with any of the alkaline sludges, will form a gummy substance and choke the pipe lines that convey them. It is therefore necessary to transport these two products in separate piping systems.

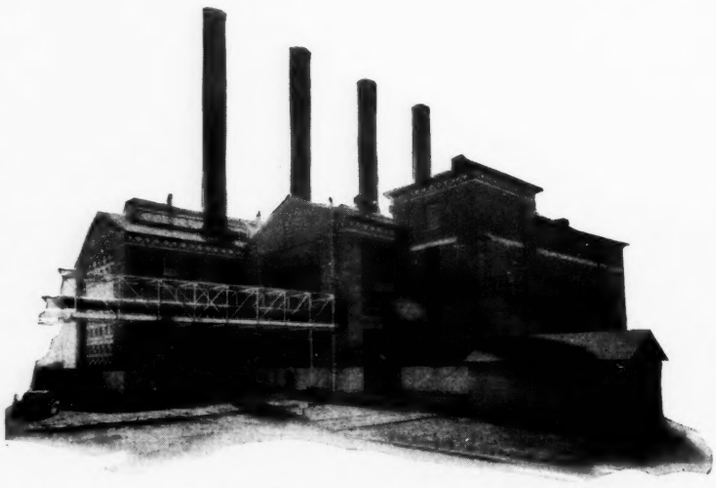
To limit, as far as possible, the number of individual lines serving each boiler, and with the intention of arranging a fairly uniform distribution of the various fuels, the acid tar system was arranged to serve boilers 1 and 2, while the lubricating sludge system is installed on boilers 3 and 4. Both of these systems, which are constructed with brass pipe and fittings, are cross-connected at each boiler to the fuel oil system so that in case of emergency fuel oil can be supplied to all burners.

It is necessary to maintain a continual recirculation at a fairly rapid rate in order to eliminate the possibility of precipitation of solids, particularly on the lines carrying lubricating sludge. All liquid and semi-liquid fuel systems are therefore equipped with lines that return surplus fuel to the storage tanks. The waste fuel pumps discharge approximately 40 per cent in excess of the actual quantity consumed in the boilers. This excess is discharged to the top of the storage tanks.

Fuel oil, soda bottoms and neutralized sludge are transported intermittently from the refinery in one 6-in. pipe line of steel construction. Wax tailings refuse is carried in a 6-in. steel pipe line, while lubricating oil sludge and acid tar are delivered to the power station from the oil refinery in 6- and 4-in. lines, respectively, constructed of brass pipe and fittings.

Arrangements have been made on the power station property for storage of all of these fuels. They are to be delivered to storage tanks at a temperature of approximately 200 deg. F. Two 500-bbl. steel tanks have been provided for wax tailings, soda bottoms, and neutralized sludge; two 750-bbl. steel tanks, lead-lined throughout, for acid tar; two 1,000-bbl. steel tanks, lead-lined throughout, for lubricating oil sludge; and two 2,000-bbl. standard steel tanks for fuel oil emergency supply.

It is necessary to maintain the temperature of all of the waste fuels as high as possible, and in any case not under 165 deg. F., to prevent caking of the liquids and to permit easy flow through the pipe lines. Therefore, steam jet nozzles are installed in the bottoms of all waste-fuel tanks, for the purpose of heating the fuels and for agitating the liquids to prevent precipitation in the tanks of the sediment which forms a large percentage of the bulk of these fuels. Fittings have been provided on the tanks for draining water as it accumulates in the tanks from the steam jets. A closed-coil heater is also used for lubricating sludge, as it is necessary to heat this fuel to about 225 deg. F. to obtain efficient mechanical atomization. After a run on any of the waste fuels, it is necessary to blow out all lines with steam. Steam connections are provided at close intervals and at all turns in the piping system.



Exterior view of Louisiana Station of Louisiana Steam Products, Inc.

The waste fuels are handled between the boilers and the storage tanks, located in the station yard, by National Transit Company reciprocating steam pumps. Two 90-gal-per-minute units and two 40-gal.-per-minute units are provided for lubricating sludge and acid tar, respectively. Two 40 - gal. - per - minute pumps handle the other waste fuels. Fuel oil is discharged by gravity from the storage tanks, in the yard, to two service tanks located below the basement floor in the power station. Two 60-gal. motor-driven, one 40-gal. motor-driven and one 40-gal. turbine-driven Quimby rotary pumps are provided for fuel oil service between the service tanks and the boilers. Two heaters, each having a capacity of 90 gal. per minute, are installed for fuel oil heating service. The operating discharge pressure of all pumps is 275 lb., and the maximum

temperature developed in the closed heater equipment for fuel oil and lubricating sludge is approximately 300 degrees. Strainers for removal of solids are installed in all lines carrying the liquid fuels.

The various classes of coke are delivered in railroad cars from the refinery in sizes varying from granulated to lumps as large as 12 in. The coke is dumped from the cars to a track hopper, from which it is discharged by a reciprocating feeder to a Pennsylvania crusher, which reduces it to approximately 1¼ in. The coke is transported from the crusher to two 160-ton overhead storage bunkers by a system of inclined belt-type conveyors.

The coke storage bunkers are provided with conical bottoms, with facilities for drainage of water carried into the bunker. Two Hardinge pulverizing mills, each having a capacity of 5,500 lb. per hour, comprise the initial installation for coke-pulverizing service. Two additional pulverizing mills will be provided in the future if found necessary. From the pulverizers, the powdered coke and air mixture is blown to the burners by motor-driven exhauster fans.

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Automatic Control For Refrigerating Machinery

By ROBERT S. WHEATON

Vilter Manufacturing Company

THE PURPOSE of an automatic control equipment for a refrigerating or ice making plant is to so operate the equipment that the maximum amount of refrigeration is obtained at all times with a minimum of supervision on the part of the operator. As there are four different things that must be cared for by an automatic control, the control is of necessity more or less complicated. For instance, the condensing water to the condenser must be regulated, the amount of ammonia fed to the evaporators must be regulated, a guard must be placed over the motor to prevent damage to it from either overload or undervoltage, and the moving parts of the equipment, which are principally in the compressor, must be lubricated throughly and completely at all times.

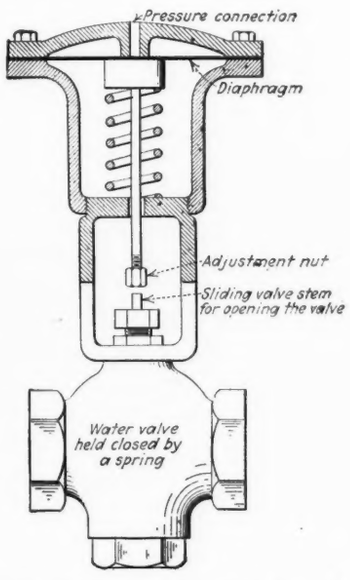


Fig. 1—Automatic valve for the condenser water

Automatic control for regulating the water supply to the condenser is usually taken care of by a valve which is opened by the pressure exerted on a diaphragm. The basic idea governing the operation of this equipment is illustrated in Fig. 1. The diaphragm is connected onto the ammonia condenser and when the compressor starts and builds up a pressure in the condenser, the increased pressure deflects the diaphragm, which opens the water valve. When the compressor ceases to operate, the water flowing over the condenser condenses the gas to a point where the pressure drops below normal, which permits the water valve to close.

Since all water carries some sediment, a strainer should be installed ahead of the water valve to prevent any sediment from lodging on the seat of the valve and thereby preventing the proper closing of the valve when the compressor is shut down. Another important detail is a bypass around the valve so that if it ever becomes necessary to make repairs on the valve the bypass can be opened and the plant kept in operation.

There is one other type of automatic water valve, which is a simple mechanical device operated by the crankshaft of the compressor. The device consists, essentially, of two weights, which when spun around exert enough pull, by centrifugal force, to open the water valve. This type of automatic water valve is usually limited to very small sizes of equipment.

Automatic Expansion Valves

For the control of the ammonia feed there are several automatic types of valves available. The basic elements of what is perhaps the simplest of all automatic expansion valves are shown in Fig. 2. It is nothing more or less than a pressure-reduction valve, applications of which are familiar in many branches of engineering. By means of the adjusting spring the valve may be regulated so that it will automatically maintain any predetermined pressure in the evaporator, or low-pressure, side of a plant. Like all pressure-reduction valves, however, it is subject to several faults, the principal one

being diaphragm failure. However, manufacturers of this equipment are now building better diaphragms.

Another ill to which this valve is subject is cutting of the valve stem and seat due to wire-drawing. This fault has been made less objectionable through the use of removable valve stems and valve seats. As these valves are invariably placed in a circuit with a stop valve on each side of the automatic expansion valve, it is a

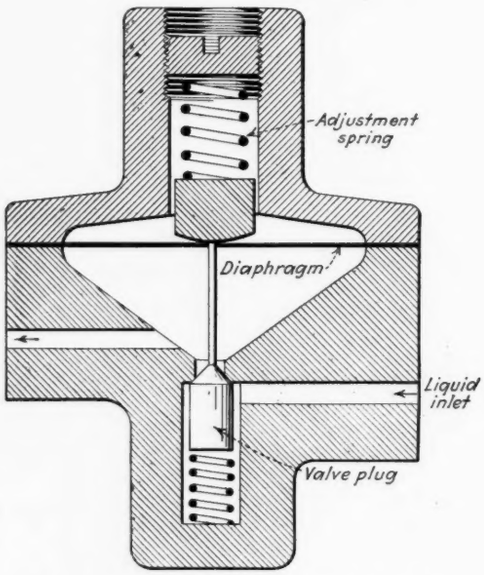


Fig. 2—A pressure-reducing type of valve

comparatively simple matter to take the valve out of the circuit and make repairs.

As in the case of the water valve, it is often advisable to arrange a bypass circuit around the automatic expansion valve circuit so that operation of the plant can be carried on even while the automatic valve is being repaired. An ammonia strainer should always be placed ahead of all automatic expansion valves, because ammonia is a powerful cleanser and will remove scale and imbedded dirt from the interior surfaces of the pipe connections and carry this dirt and scale along toward the valve. Strainers are made in various designs, varying from the large pot-type with a fine screen in it to the small strainer which not only contains a screen but is also filled with a mineral wool packing.

Another feed-control valve of the automatic type is the so-called thermally controlled automatic expansion valve, made in several different styles but are all operated on the following principle: The valve operates in accordance with the condition of the ammonia gases leaving the evaporator. If the ammonia gases are superheated when leaving the evaporator the valve is automatically opened, thereby permitting more ammonia to flow and correct the superheating condition.

On the other hand, if the gases leaving the evaporator carry unevaporated ammonia in suspension, the valve automatically closes until the gases begin to leave the evaporator in a slightly superheated condition, whereupon the valve automatically reopens. This is of particular benefit in installations where the load on the evaporator is continually changing. For instance, in a refrigerating plant where brine is used as the refrigerating medium, at the end of a run the brine has warmed up considerably. When the compressor takes up the load the brine is, of course, gradually cooled again, and as the brine cools, the load requirements change. This is where a thermally controlled valve finds an excellent application, for no matter how the load changes on the evaporator, or low-pressure, side, in this case the cooling element in the brine tank, the feed is so regulated to the evaporator that the maximum cooling efficiency is maintained during any operating period of the compressor.

The essential parts of a thermally controlled automatic expansion valve appear in Fig. 3. A thermal bulb *A* is inserted in the suction line in such a manner that the suction gases leaving the evaporator create the same temperature in the thermal chamber as exists in the suction gases. A second thermal chamber *B* in the valve operates on a diaphragm *C*, which, in turn, actuates the valve needle or plug. Thermal bulb *A* and the valve and low-pressure side are evacuated thoroughly before the plant is started up. Ammonia gas is then introduced into the thermal bulb *A*, as well as into thermal chamber *B*, by appropriate means and then sealed off in these two containers from the rest of the low-pressure side. When the plant is started up the suction gases sweeping over the thermal bulb *A* create inside of the bulb the same temperature as exists in the suction gases. This pressure is transmitted through the connector tube to the thermal chamber *B*.

If the plant is operating at, say, 20 lb. suction pressure, which corresponds to a saturated temperature of ammonia gas of 5.5 deg. F., then the same pressure and temperature will be created or generated inside of thermal bulb *A* as exists in the suction line. If, through lack of ammonia, the suction gas began to return at, say, 3½ deg. superheat, this higher temperature would generate the same temperature inside of the thermal bulb, and as the

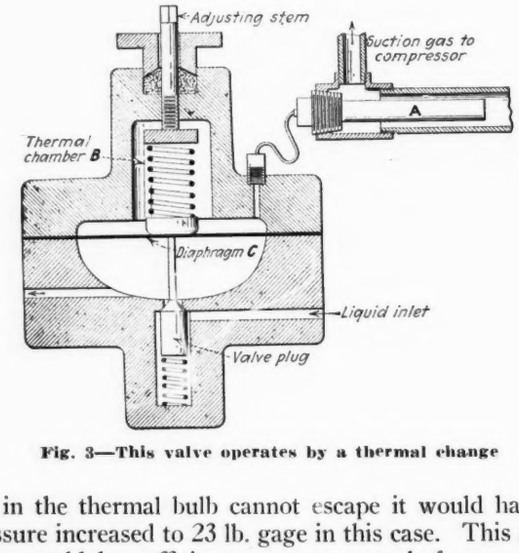


Fig. 3—This valve operates by a thermal change

gas in the thermal bulb cannot escape it would have its pressure increased to 23 lb. gage in this case. This added 3 lb. would be sufficient to exert enough force on diaphragm *C* to push open the needle valve and admit more ammonia into the low-pressure side, and this action would be sustained until the gas returning through the suction line and sweeping over the thermal bulb *A* would again chill the gases locked up inside of the thermal bulb, decreasing the pressure in the thermal bulb accordingly and thereby releasing the pressure on the diaphragm and closing off the feed valve. This action is continuous throughout the operating range of pressures and has proved to be a most desirable method of controlling the liquid ammonia feed to an evaporator.

Of course, there are numerous designs employed in working out this control. Some types have the thermal chamber surrounding the suction pipe, some have the thermal chamber inserted inside of the suction pipe and some have the thermal chamber embodied in the valve. In the last case the thermal chamber is insulated from the feed part of the valve by an insulating disk placed between two diaphragms.

In addition to the types of feed control equipment mentioned, there is the float-valve method of control. This may embody either high-pressure or low-pressure floats. As the name implies, this type of feed valve, Fig. 4, is opened or closed by the action of a float and is usually operated in connection with an ammonia accumulator. The operation of the low-pressure equipment is quite simple. When the levels of the ammonia in the evaporator and accumulator reach any predetermined height the float rises and closes off the ammonia feed.

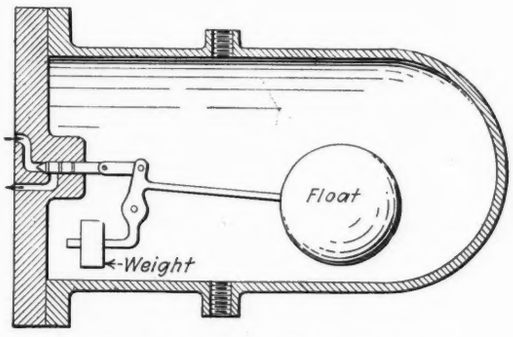


Fig. 4—A float to control the liquid level

The high-pressure float operates just the reverse of this, and is usually found on the smaller sizes of installations where a predetermined ammonia charge is placed in service. When all of the ammonia has left the liquid receiver and has been fed into the evaporator, the float, having nothing to buoy it up, falls down and closes off the liquid outlet and keeps it closed off until liquid ammonia again accumulates in sufficient quantity to raise the float and reopen the valve. The function of this type of equipment is to form a seal between the high-pressure and low-pressure sides so that the ammonia condenser pressure can be maintained.

The liquid supply should be led around the float chamber, because if it is not the violent action set up in the float chamber when a portion of the ammonia flashes into gas, upon passing the orifice in the feed valve, will tend to interfere with the operation of the float. The float chamber is joined by means of equalizing connections to the evaporator and the accumulator so that the liquid level in the float corresponds to the liquid level in the accumulator. It is to be remembered that the installation of one of these float valves presents a problem which must be solved in the correct manner in each particular installation, because the location of the float with reference to the equipment is of extreme importance.

Power requirements for the typical automatic plant are usually served by means of an electric motor belted to the compressor. It was customary a few years ago to use a belt and belt idler, which usually eliminated any chance for the belt to run off of the equipment when starting up. But when starting an automatic plant the load conditions are usually severe, and a motor of proper design, as well as an efficient belt drive, must be employed. More recently the V-belt drive has proved to be most desirable for this class of service.

The starter for the motor should be provided with a low-voltage protection and an overload protection, to promptly cut out the motor from the line in event of abnormal conditions. As these electrical conditions rarely occur in most installations, this part of the automatic control sees but little service.

Another protection of great value is the automatic high-pressure cut-out device. This consists of an equipment actuated by the pressure existing in the condenser in such a way that if this pressure passes a predetermined point the device will stop the motor from operating, and, if desired, will either light a lamp or ring a bell as a warning. This automatic cut-out is commonly caused to operate by stoppage of the water flow on the ammonia condenser resulting in an abnormal high pressure in the condenser. Stoppage of the water flow is generally caused by a clogged strainer.

Thermostat Should Be Outside

To operate the plant, a means must be supplied to start and stop the equipment when predetermined temperatures are reached. This is done by means of a thermostat. There is one thing which must be remembered in regard to thermostats in refrigerating work: A thermostat, especially the type that makes use of a sylphon bellows, should be placed outside of the refrigerator room, because if the thermostat becomes chilled moisture condenses on it in the form of frost and the bellows will eventually be rendered inoperative. To guard against such an occurrence the thermal bulb containing the actuating gas is fitted with sufficient connector tubing so that the bulb can be placed where desired in the refrigerator room and the thermostat placed outside of the room. This is especially true of freezer room controls, and, of course, of all brine tank controls.

If a number of rooms operated by one compressor are to be made fully automatic in operation the equipment is likely to become rather complicated. However, each room may be considered as independent of the others. The piping should be arranged, especially in freezer rooms, so that on starting up ammonia slugs will not be carried back to the compressor.

Propeller-Type Pump Shows High Efficiency

By J. W. McNULTY
Engineering Department
Westinghouse Elec. & Mfg. Co.

Two vertical pumps of this type deliver circulating water to the condenser at James H. Reed station of the Duquesne Light Company

THE CIRCULATING-WATER pumps serving the single-pass 55,000-sq.ft. condenser at the James H. Reed station on Brunot's Island near Pittsburgh depart from customary practice both as regards the type of pump and their location in the plant. The two pumping units, of vertical propeller-type, are each rated at 40,000 g.p.m. against a total head of 16.63 ft. They are driven at 575 r.p.m. by 350-hp. vertical induction motors.

These units are located in a screen house on the bank of the Ohio River. The circulating water is pumped through 72-in.-dia. cast-iron pipes to the power house intake tunnel, and is discharged through tunnels to the river channel on the opposite side of the island.

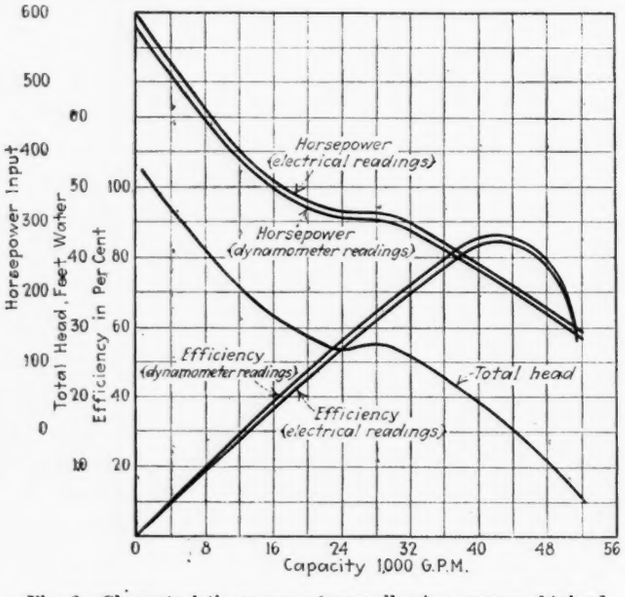


Fig. 2—Characteristic curves of propeller-type pump obtained from shop test

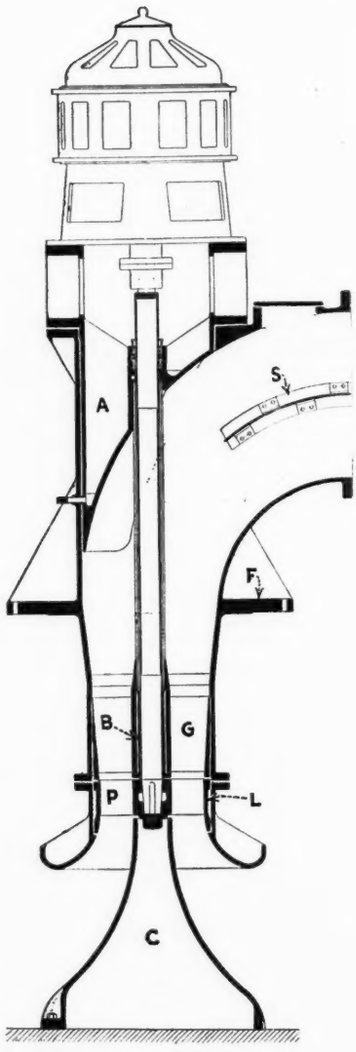


Fig. 1—Section through propeller-type condenser circulating-water pump

Fig. 1, a cross-section through the pump, gives an idea of the simplicity and compactness of its design. The water is guided into propeller *P* through the nozzle formed by the tunnel guide cone *C* and the bell-shaped end of the pump. After leaving the propeller the water passes through guide vanes *G* and thence into the body of the pump, which takes the form of a diffuser, wherein the velocity is reduced and converted into pressure in an efficient manner. A splitter *S* is installed in the discharge elbow to reduce the losses at that point.

The propeller rotates in a renewable liner *L* of bronze or other suitable material. A water-lubricated Goodrich rubber bearing *B* in the center of the guide vane casting takes the radial load. Liberal clearance is allowed between the propeller and liner, since the efficiency of the pump is not affected appreciably by the amount of clearance at this point. The pump is mounted on its feet *F*, which carry the combined weight of the pump and motor. Only one gland is necessary, contained in the pump plug *A* and under pressure.

Fig. 3 shows the guide vanes with the rubber bearing in place. The bearing has spiral grooves which permit circulation of water for lubrication. In Fig. 4 the guide

vanes, propeller and shaft are shown assembled. This assembly can be withdrawn from the pump for inspection or repair without interfering with the casing and piping, by removing the motor and plug *A* at the top of the pump.

The tunnel guide cone (*C*, Fig. 1) is only necessary in cases where the tunnel dimensions are limited. If the tunnel section is sufficiently large and deep, the bell-shaped inlet to the pump will impart the necessary streamline flow to the entering water. In this case a bullet shaped nut is used to fasten the propeller on the shaft.

When desirable the pump may be installed vertically in a horizontal pipe line, and a gate valve may be placed adjacent to the propeller without impairing the efficiency. This permits the use of the smallest possible valve. While the illustration shows the pump installed vertically, it is equally adaptable to application in a horizontal position.

Test Results Show High Efficiency

One of these pumps was given a complete capacity test before shipment from the factory. The water was measured by a 60-in. Venturi meter in the discharge pipe line. The discharge head was measured in the straight section of pipe adjacent to the pump. Two piezometer rings were installed at different locations along this pipe, so that variation in pressure due to irregular flow could be detected. However, no perceptible difference was noted in the readings from these two rings. The suction head was taken as the level of water in the test pit.

The power was measured by two devices. Energy input to the pump shaft was obtained by referring the electrical input to the motor to high-accuracy motor test curves. For an independent check, the entire motor was mounted on a horizontal ball race, and the power input to the pump obtained from the torque of the motor was measured by the dynamometer method. A flexible cable was wrapped around the motor base, carried over a sheave mounted on ball bearings, and attached to a spring, which was, in turn, attached to a large weight on a platform scale. The scale reading subtracted from the tare weight gives the force used to calculate the torque. The purpose of the spring was to provide for oscillation of the motor and thus increase the accuracy of the platform scale readings.

The power input indicated by the two methods did not check exactly, the discrepancy being about 7 hp. in 235, or 3 per cent. Some of this discrepancy can be attributed to the loading, and consequent loss on the ball thrust bearing, which carried the combined weight of the motor and pump rotating elements as well as the hydraulic thrust. Fig. 2 shows the characteristic curve of this pump as obtained from test corrected to a constant speed of 575 r.p.m. The speed actually varied somewhat from this nominal figure, due to varying load conditions at the several points.

The high efficiency obtained with this pump can be attributed to three fundamental features: (1) the propeller has only two cutting edges; (2) the propeller surface in contact with the water, and causing friction, is a minimum for the volume handled; and (3) the design of the pump is such that it reduces to a minimum the losses resulting from changing the velocity and direction of flow of the water within the pump. It is interesting to note that the tip diameter of the propeller for the pumps is only $30\frac{7}{8}$ in. One third of this diameter is taken up by the hub.

This type of pump is inherently suited to the handling of large volumes against low heads. There is no minimum limit to the head for which it can be applied and produce maximum efficiency. The only factor that limits the maximum head at best efficiency is the velocity through the propeller. This velocity must be kept within the limit that can be obtained safely with the available absolute pressure at the propeller inlet. Thus it is evident that if the pump can be submerged under a positive head of fluid a higher velocity through the propeller is possible and a correspondingly higher head can be obtained at the point of best efficiency. Numerous experiments have proved that the value of the maximum efficiency obtained is not affected by the head and capacity conditions for which the pump may be designed so long as the velocity through the propeller does not too closely approach the maximum velocity theoretically obtainable.

Fig. 3—Guide vanes, showing water-lubricated rubber bearing

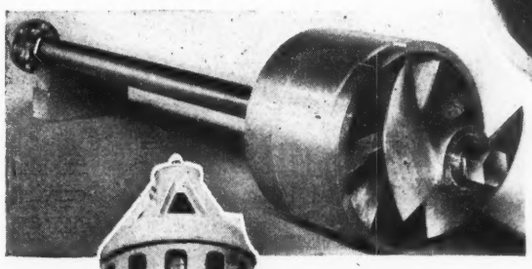


Fig. 4—Assembly of shaft, propeller and guide vanes

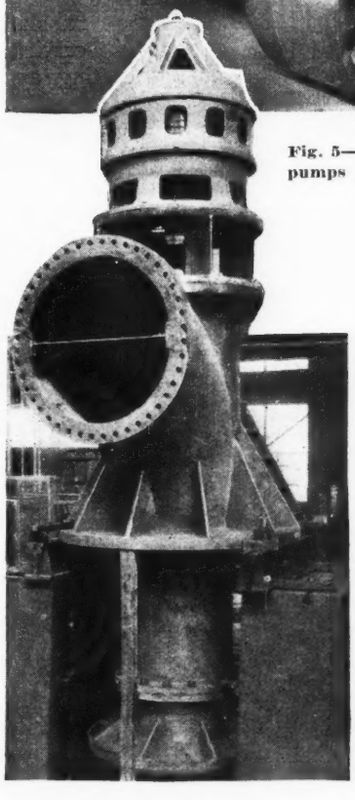


Fig. 5—One of the 48-in. propeller-type pumps for the James H. Reed station

Modern Steam-Electric Marine Power Plants

The Santa Clara, steam-turbine electric ship of the Grace Line

By FRANK V. SMITH
Federal and Marine Department
General Electric Company

In ever-increasing numbers "central stations" sail the seven seas and rival their land-locked brothers in size and efficiency. The adaptation of steam-electric practice to ship propulsion is yielding new experience which may, in turn, react favorably on the design, construction and operation of plants ashore

THE MODERN marine power plant might be said to be a "chip off the old block," the central station. Its peculiarities are due to its environment. Weight and space limitations aboard a ship have "cramped its style," but not its power. Two ships, the airplane carriers Saratoga and Lexington, have each an installed capacity of 140,000 kw. A number of trans-Atlantic liners are also being projected which will have an equal or greater amount of power. The race for the blue ribbon pennant is on, with England, Germany, France and the United States toeing the mark. The thousand-foot liner of 30 knots now appears a certainty.

It is estimated that it takes from 140,000 to 160,000 hp. to drive these monstrous ships at 30 knots. It will take a reserve power of from 40,000 to 60,000 hp. above the normal requirements to be assured of the blue-ribbon pennant. From the standpoint of power, then, the marine plant commands quite a little respect.

With power on one side, and weight and space on the other, not all of the economic refinements which find use in central station practice on shore can be applied to ships. There is, however, a pressing need for fuel economy, because a ship must carry fuel for its entire voyage. This, in turn, adds to the weight of the ship and therefore the power required to drive it. Hence fuel economy yields a double saving to the ship owners.

A ship's power plant differs in many respects from the central station. In the first place it is more inclusive; a ship carries the power-using as well as the power-generating apparatus. What is generally termed the "house load" in the central station is much more extensive on a ship. There is what is called the "hotel load" —current required for lighting, heating of staterooms, cooking, ventilation, elevators, and miscellaneous electrical appliances. Then there is the current required for the steering apparatus, refrigeration (both ship's stores and cargo), ship's drainage, fresh-water systems, sanitary systems and fire systems. Extensive cargo loading and unloading apparatus—boat cranes and hoists, capstans and anchor windlasses—add to the long list of items requiring electircal power. The engine room auxiliaries or those which function in conjunction with the main power plant, of course, are similar to those found in a central station.

The electrical apparatus differs in many respects from that used on shore. Motors must be designed to operate satisfactorily at a tilt. They must have non-corrosive fittings and in many cases must be made waterproof. The open type of motor has but a limited application on a ship.

In considering the power needs of a vessel, flexibility and reliability are of first importance. The maneuvering of a vessel requires large intermittent uses of power. When going at full speed she may be called upon sud-

denly to stop or reverse. This means that a very close co-operation must exist between the engine and fire rooms.

The main turbine-generators which supply power to the propelling motors are not constant-frequency machines. They vary in speed directly with the propelling motor revolutions. When a ship is under way the propellers absorb power according to the cube law—that is the power goes up as the cube of the speed. This means also that the motor torque varies as the square of the revolutions. The generators and motors are designed with respect to their combined torque characteristics, and as current varies with torque it means that the voltage of the system must also be varied for best results.

In merchant ships the synchronous type of motor is generally used, with a squirrel-cage winding embedded in the polefaces for starting. After the motor is brought into synchronism the excitation of the motor and generator is adjusted to give unity power factor, and to give sufficient voltage to prevent the motor from falling out of step. The voltage carried depends upon the sea conditions.

During a heavy storm the power variations may become severe, and the propellers may emerge from the water one instant and be deeply submerged the next. The governing system on the turbine must be designed to take care of these conditions. There are two solutions: first, to govern for constant speed; and, second, to govern for constant steam flow. The first is not entirely applicable under heavy sea conditions, because it would cause a pulsating flow of steam from the boilers, with danger of priming. The second is not entirely applicable, because if the propeller emerged from the water the release of torque would cause overspeed. A compromise between the two systems is therefore required. The speed governor is set slightly above the steam flow setting and the high speed peaks are nipped in the bud.

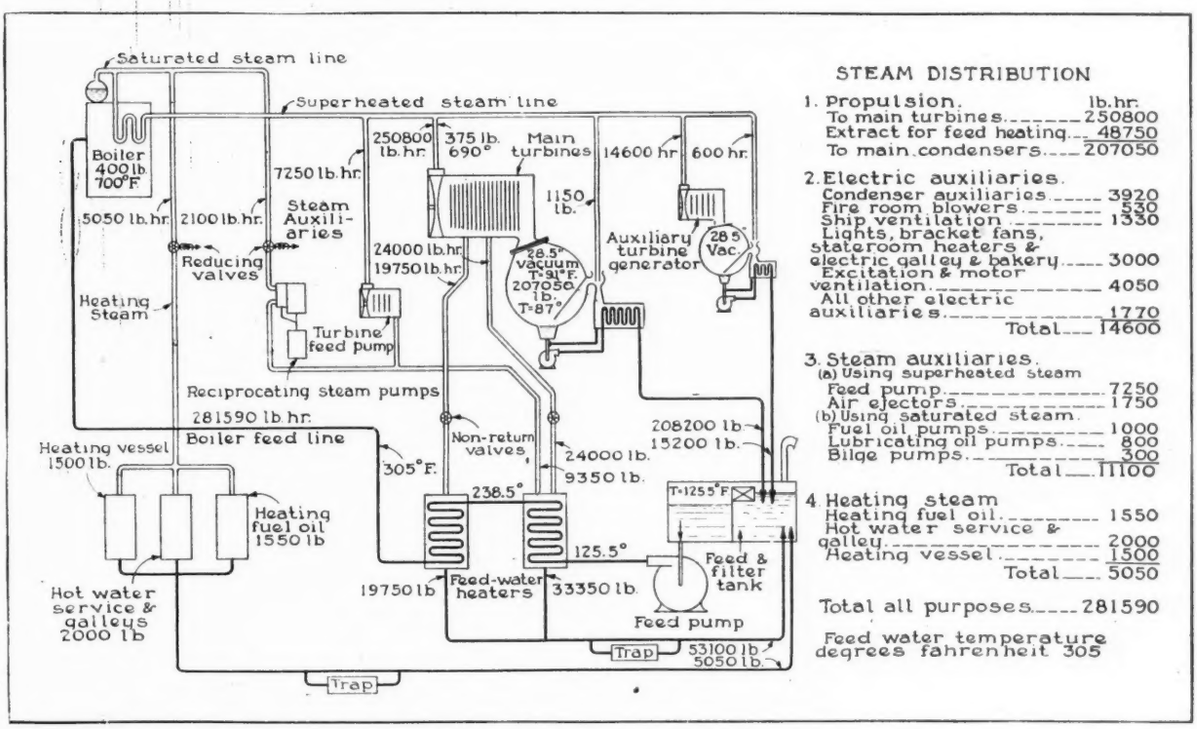
The variable-frequency and variable-voltage characteristics of the main turbine-generators do not make it feasible to take power from them for auxiliary purposes, either through transformer or motor-generator set, except under constant operating conditions and when the frequency and voltage are confined within certain limits.

This has, however, been accomplished on ships of small power by installing what is known as a "dual-drive" set—a motor, a generator and a turbine all connected in tandem. When the main propulsion generator is operating at between 70 and 100 per cent of its rated frequency, power is taken from it to drive the motor-generator set and the attached turbine is allowed to idle. An automatic device opens the throttle of the turbine, which drives the motor-generator set, when the main line frequency drops below 70 per cent, and at the same time opens the contactors to the motor. There have also been some variations to this system.

On ships of large power it has been found desirable to install separately driven turbine-generators to supply the auxiliary power. Whether these are direct- or alternating-current machines depends somewhat upon the size of the ship. Up to the present they have usually been direct-current machines. Recent studies, however, show the practicability of using alternating-current auxiliary motors, and great advancements are constantly being made in the application problems involved.

The use of direct-connected exciters is not feasible on ships having synchronous propelling motors, because of the low speed of the main turbine-generators when phasing in the motors. They have been used, however, on ships employing the wound-rotor type of induction motor where it is not necessary to reduce the speed of the prime mover below 70 per cent when starting the propelling motor. In such cases temporary low propeller speeds (for maneuvering) are obtained by inserting resistance in the rotor circuit of the motor. Because of the heavy duty on the resistors, they are generally of the water-cooled type.

From the foregoing it is obvious that the marine application engineer has his problems. Each individual ship



Typical steam distribution arrangement for a 30,000 s.h.p. steam-turbine electric-driven twin-screw ship

involves a separate study, and decisions are not made until all the facts are known.

Many of the economic measures which are applied in shore plants can be used only in modified form on ships; others cannot be used at all. Notwithstanding this fact, the over-all efficiency of the marine power plant compares very favorably with that of the best central station, when proper evaluation is made for the extra house load and the compromises necessary to flexibility, space and weight.

Boiler pressures of 400 lb. and steam temperatures of 700 deg. F. are being freely figured on new installation work. Studies of pressures up to 650 lb., and temperatures of 750 deg. F., have been completed, and the application engineers are ready to proceed to this higher region of pressures and temperatures as soon as economic conditions warrant. The use of air preheaters or economizers to salvage part of the stack gas losses receives consideration on practically all new installation work, and steady progress is being made in that direction. Weight, space, first cost and upkeep, balanced against fuel saving, which, in turn, is dependent upon length of trade route, time in service, etc., are the deciding factors in each case. Overall boiler efficiencies (with air preheaters or economizers) based on fuel oil as fired now range from 85 to 87 per per cent. In a few scattering instances even higher values than this have been claimed.

In marine work it is problematical if steam reheating can be used advantageously as an additional economic measure. If steam pressures were carried to 1,400 lb. it would, of course, be necessary in order to avoid the high moisture content in the last stages of the turbine. At present the goal is to elevate the initial temperature consistently with the pressure so as to limit the moisture content in the last stages. How far this can be carried depends upon progress in the metallurgical arts. It is thought by a few that some binary-vapor cycle will probably precede the use of reheat in marine work.

Series feed-water heating by the extraction method is finding ready application in marine plants. In installations using economizers, it is not, of course, being carried as far as in installations having air preheaters. When economizers are used the temperature of the feed-water from the last-stage feed heater is kept at about 240 deg., to prevent condensation of moisture on the economizer tubes. When air preheaters are used a high-pressure feed-water heater is installed to maintain a feed-water temperature of from 300 to 325 deg. The small gains above this region do not warrant the inclusion of an additional feed heater under present steam conditions.

The reduced amount of steam entering the condenser with an extraction system represents a real gain in marine practice. It not only reduces the required last-stage area of the turbine, thereby reducing the weight and dimensions, but it also permits of the use of a smaller condenser, with lesser power requirements on the condenser auxiliaries.

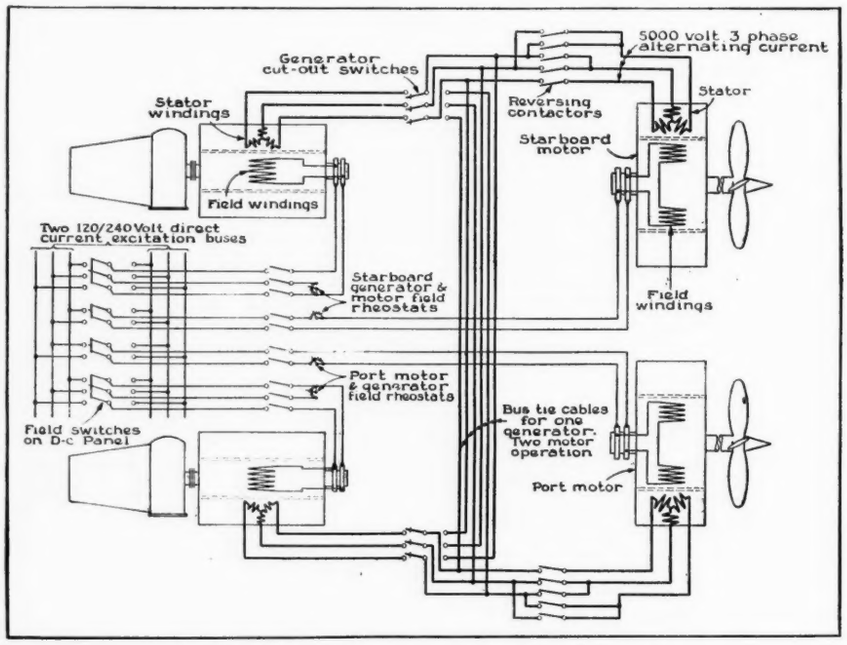
The turbine efficiencies in marine work are quite high. Turbine speeds are generally above those used in central station work. Frequency is out of the picture. Efficiencies now range from 77 to 81 per cent, depending upon the power rating and the initial steam conditions.

The increase in boiler pressures and steam temperatures has accentuated the need for pure, deaërated feed water. Distilled water is used for boiler feed, and large evaporator plants are installed for that purpose. In merchant ship work it is usual practice to operate the evaporator at 10 lb. gage pressure and to utilize the steam so raised in an intermediate pressure feed-water heater. The feed-water heater therefore becomes the distiller and returns the latent heat to the boilers. The loss in the system is quite small, consisting mainly of the radiation loss and that involved in heating the evaporator feed.

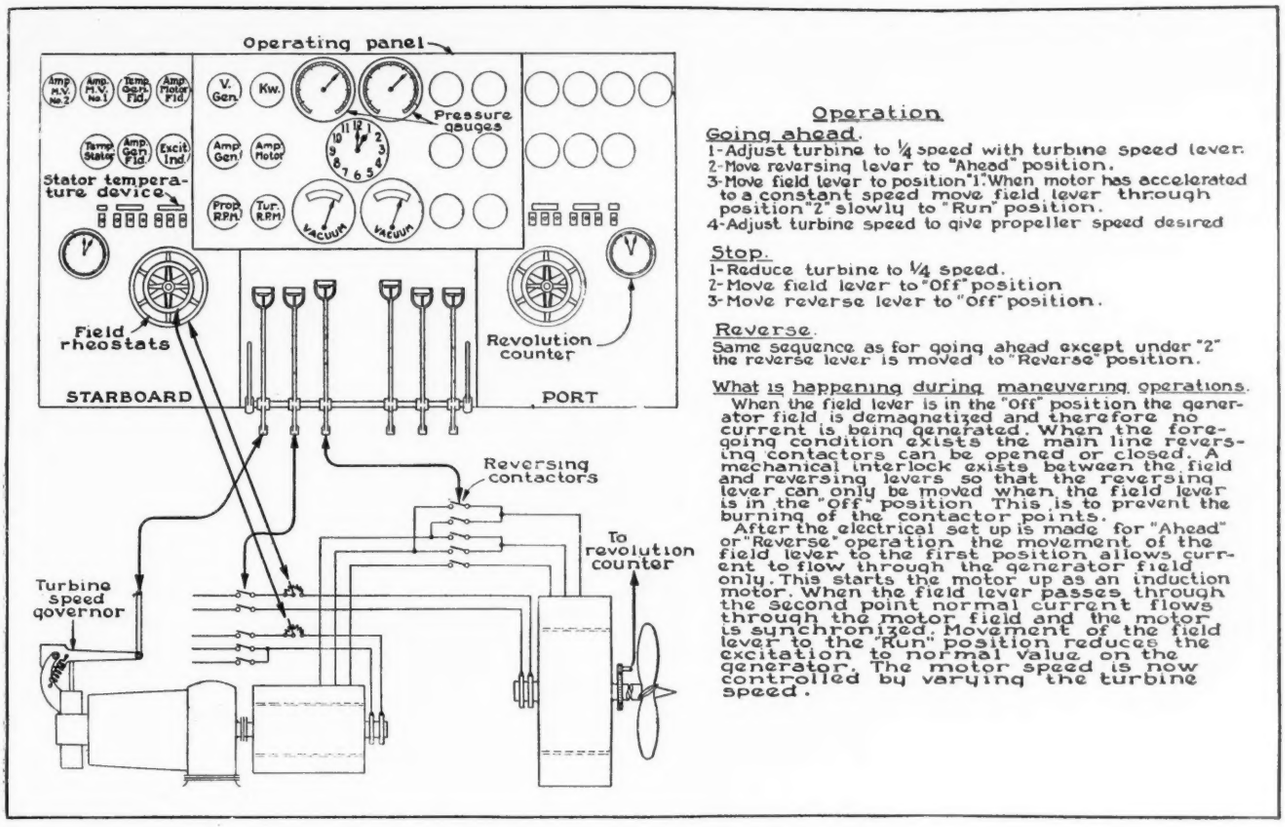
Deaëration of the feed water is accomplished either by installing a completely closed system or by heating the water in the feed and filter tank to a reasonably high temperature before it enters the closed part of the system. It has not been found practicable to electrify all of the engine room auxiliaries, although steam-driven auxiliaries are kept to a minimum. The fire pump and the fuel oil pumps in the fire room are usually steam-driven. These two do not upset the maintenance of a proper heat balance under port conditions of operation.

There is a constant need for a small amount of low-pressure saturated steam for such purposes as heating the fuel oil, heating the public spaces, galley, laundry and hot-water service. High-pressure, high-temperature steam installations slightly complicate the problem. This difficulty has been overcome by passing a small superheated steam line through the steam drum of the boiler for desuperheating purposes, and thence through a reducing valve. The very few steam reciprocating pumps may then be operated from this same line. When the ship is in port, and the ratio of saturated steam to superheated steam used is quite high, this arrangement insures a constant flow through the superheater tubes, thus preventing their burning out.

In some installations a high-pressure evaporator type of boiler has also been considered, which generates its steam at 100 lb. pressure; in this case the generated



Simplified wiring diagram of main and field circuits


Operating panel
Pressure gauges
Stator temperature device
Field rheostats
Revolution counter
STARBOARD
PORT
Reversing contactors
To revolution counter
Turbine speed governor
Operation
Going ahead.
1-Adjust turbine to ¼ speed with turbine speed lever.
2-Move reversing lever to "Ahead" position.
3-Move field lever to position "1". When motor has accelerated to a constant speed move field lever through position "2" slowly to "Run" position.
4-Adjust turbine speed to give propeller speed desired
Stop.
1-Reduce turbine to ¼ speed.
2-Move field lever to "Off" position
3-Move reverse lever to "Off" position.
Reverse.
Same sequence as for going ahead except under "2" the reverse lever is moved to "Reverse" position.
What is happening during maneuvering operations.
When the field lever is in the "Off" position the generator field is demagnetized and therefore no current is being generated. When the foregoing condition exists the main line reversing contactors can be opened or closed. A mechanical interlock exists between the field and reversing levers so that the reversing lever can only be moved when the field lever is in the "Off" position. This is to prevent the burning of the contactor points.
After the electrical set up is made for "Ahead" or "Reverse" operation the movement of the field lever to the first position allows current to flow through the generator field only. This starts the motor up as an induction motor. When the field lever passes through the second point normal current flows through the motor field and the motor is synchronized. Movement of the field lever to the "Run" position reduces the excitation to normal value on the generator. The motor speed is now controlled by varying the turbine speed.

Operating panel for controlling the ship's propellers

steam supplies the low-pressure saturated steam requirements as well as the make-up feed.

The diagram on page 65 represents a typical steam distribution arrangement for a twin-screw 30,000-shaft horsepower turbine-electric driven liner. The total steam flow of 281,590 lb. per hour, with a feed-water temperature of 305 deg. F., represents a heat expenditure of 10,155 B.t.u. per shaft horsepower-hour for all purposes.

With fuel oil having a heat value of 19,000 B.t.u. per pound and a boiler efficiency of 87 per cent, the fuel rate per propeller shaft horsepower-hour for all purposes would be 0.615 lb. This represents an over-all thermal efficiency (fuel as fired) of 21.8 per cent.

Steam consumption of the main power plant, including its necessary auxiliaries, plus the steam extraction for all purposes, represents about 94½ per cent of the total, or about 9,600 B.t.u. per shaft horsepower per hour. This reduces to 0.58 lb. of oil per shaft horsepower per hour, or an over-all thermal efficiency (fuel as fired) of 23.1 per cent.

To place the thermal efficiency of a marine power plant on the same basis as that of a central station it is necessary to correct for the propelling motor efficiency with its excitation, because the central station efficiency does not involve the power-using apparatus.

Allowing for a propelling motor efficiency (with excitation) of about 97.5 per cent, the over-all thermal efficiency is 23.7 per cent on a central station basis. Considering that the main turbine-generators in the foregoing case are rated but 11,500 kw. each, it is obvious that the modern marine power plant has reached a high level of efficiency.

On page 66 is shown a simplified wiring diagram of the main and field circuits of the 30,000-s.hp. installation considered in this article. Under full power operating conditions one main turbine-generator supplies power to one propelling motor only. It is possible to drive the ship at 75 per cent maximum rated speed, however, with the two motors paralleled on either one of the main generators. Bus tie cables and generator cut-out switches are provided for this purpose.

The function and handling of the operating panel are shown above. Interlocks are provided between the three operating levers, which makes it necessary for the engineer to reduce the turbine-generator speed before moving the field lever, and to move the field lever before opening the reversing main-line contactors.

The operation is quite rapid, and reversal of the propellers can be accomplished normally in about 17 sec. Full power is also available for backing as well as going ahead. As vibration on the propeller shaft is not carried to the stator frame of the propelling motor, or to the prime mover, it follows that it is not carried to the hull of the ship, as in direct mechanical drive. The generators are usually provided with an inclosed air-cooling system, which, in turn, blanks off the hum. These two features have tended to popularize the electric ship with the traveling public.

Ships of the turbine-electric type that have lately been added to our fast growing and newer merchant marine consist of the California, the Virginia, and the Pennsylvania of the Panama Pacific Line; the Santa Clara of the Grace Line; and the Morro Castle and Oriento, of the Ward Line. Two large turbine-electric passenger liners are in building for the Dollar Line, and six for the United Mail Steamship Company. The yacht Corsair and the yacht Viking are also turbine-electric-propelled craft. Turbine-electric drive has also been applied to self-unloading bulk freight carriers and car ferries on the Great Lakes.

One of the industries in which power is an important item in operating cost is cotton ginning, yet there seems to be no agreement of opinion as to what power should cost per bale ginned, nor as to which type of prime mover is most economical

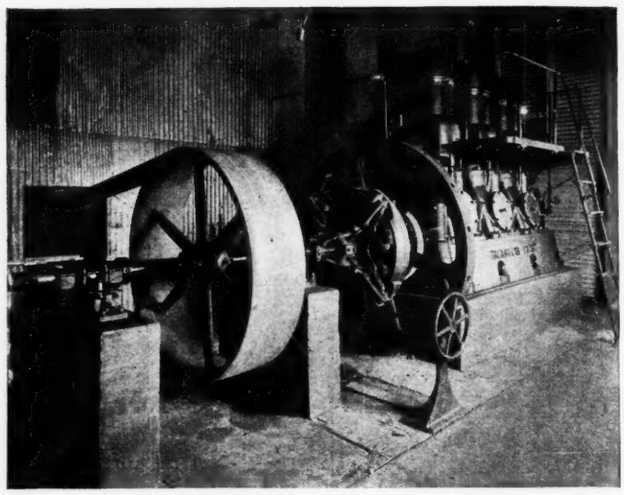


Fig. 1—Oil engine driving a gin through a cut-off coupling and pulley

Power Costs for Cotton Ginning

By ORVILLE ADAMS

COTTON GINNING has certain problems peculiarly its own. The ginner, as soon as the cotton-picking season arrives, must be prepared to gin whatever is offered. The output is low the first days and at the end of the season, yet the operating force and the horsepower demand during these low-output periods are as great as at midseason.

While steam engines are still found in some of the older plants, at present the choice usually is oil engines, gas engines or electric power.

The writer conducted an investigation of the cost of power for ginning cotton with various prime movers and motors over a period of two years in various parts of the Southwest. These reports, coming directly from the owners themselves, were in the form of answers to a series of questions, for the most part covering the number of bales ginned for the three previous years, the amount of fuel oil used, average price per gallon, and the amount and cost of lubricating oil. Expense for repairs since the initial installation was also asked for, together with the owner's previous experience with steam engines and the probable cost for steam power. Supplementing these reports were considerable personal observation and direct contact with ginning plants.

Taking more than one hundred such reports, for the diesel engine driven gins, the cost for fuel and lubricating oil per bale of cotton ginned averaged at approximately 12c. per bale. Occasional repairs were also included in that cost.

Four installations taken from the total list compiled are shown in the tabulation, with an average that compares favorably with the complete list. The cost averaged 12.5c. per bale, with fuel oil costing less than 5c. per gallon.

POWER COSTS IN DIESEL-POWERED GINS

Plant	A	B	C	D
Bales ginned	2,256	5,000	2,211	2,464
Fuel, gal.	4,000	10,000	5,000	4,050
Fuel, cost per gal., cents	4½	4½	4½	4½
Lub. oil, gal.	100	200	165	110
Lub. oil, cost per gal., cents	60	54	58	67
Repairs	$.50	$101.33	None	.....
Total cost	$248.50	$659.33	$332.20	$250
Cost per bale, cents	11.0	13.2	15	10.2

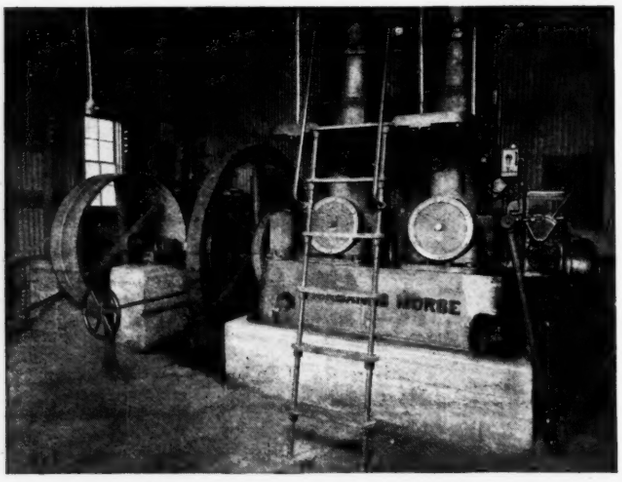


Fig. 2—100-hp. engines are more generally used than any other size

Inspection of the table will show that approximately two gallons of fuel oil was consumed per bale of cotton ginned. The basic cost with oil engines is the cost of two gallons of fuel oil plus the lubricating oil, which is shown to average from 8 to 15c. per bale, or 4 to 7½c. per gallon for fuel oil, with the small item of lubricating oil to be added. This establishes fairly well the cost of diesel power for cotton ginning.

It does not, however, take into account the initial investment of from $60 to $90 per horsepower. It is for this reason that all the diesel-powered gins investigated handled over 2,000 bales annually. Outputs less than that amount find the oil engine too expensive in first

cost if the gin must handle a high daily capacity but has a small annual output. Under these conditions a 1,000-bale gin might require the same horsepower in engines as would a 2,000-bale plant.

The high-speed diesel engine is also making considerable headway in this service, since the cost is somewhat less than the slow-speed and the installation cost a great deal less. Engines of this type installed in 1930 show a fuel cost that compares favorably with that of slow-speed engines.

The cost of ginning with purchased current depends not only upon the capacity of the gin and its annual output, but also upon the location of the gin. The investigation revealed that this cost would be from 60c. to $1 per bale for energy, without the inclusion of fixed charges. Some public utilities state that as the cotton seed mill load follows the gin season, to be succeeded by the spring irrigation load, the same generating equipment can be used to meet the three loads, so that the cotton gin need pay a demand charge or connected-load charge only during the ginning season. This reduces the power cost substantially. The consumption charge varies from 3 to 6c., depending upon the locality. The Public Service Commission of Alabama has set a fixed charge of 4c. per kilowatt-hour for the first 250 kw.-hr. per connected horsepower consumed during the season, plus 3c. per kilowatt-hour for all energy in excess of this minimum. The customer is required to guarantee a minimum of $8 per connected horsepower a season, whether energy equivalent to that amount has been consumed or not.

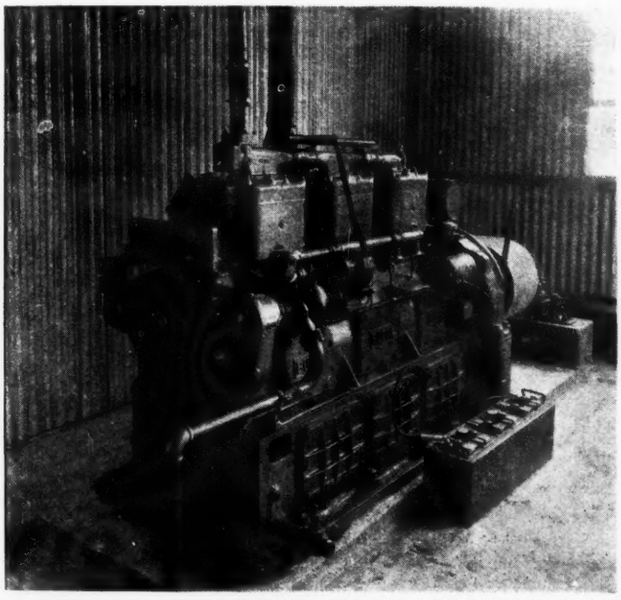


Fig. 3—High-speed gas engines are used where gas is cheap

Applying the Alabama rate schedule, a ginner having four 80-saw gin stands using 125 hp. will pay not less than $1,000 for electric current, since he must guarantee $8 per connected horsepower, regardless of the volume of business. He must gin not less than 1,250 bales to consume the minimum requirement of $125 \times 250 = 31{,}250$ kw.-hr. At 4c. this totals $1,250, or $1 per bale. The oil engine power cost for fuel and oil even with such a small volume of business would be about $150 or less, but its fixed charges would be higher.

Natural-gas distribution lines are spreading to many sections of the cotton belt, making available fuel to thousands of cotton gins adjacent to the pipe lines. A considerable number of ginners are taking advantage of the cheap fuel, since a gas engine costs much less than an oil engine, and the fuel cost is often about the same.

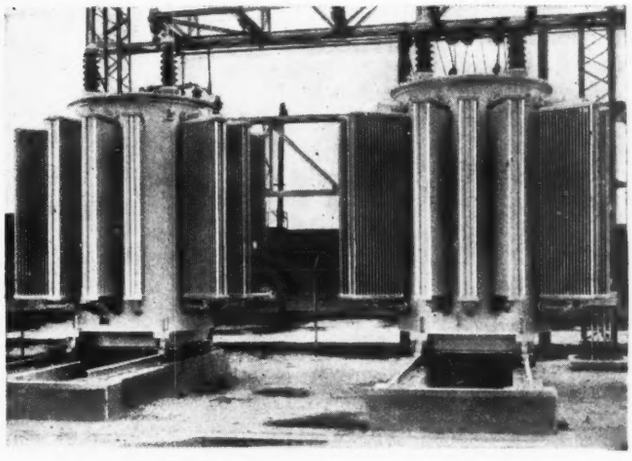
In fifteen gas engine installations which have come under my observation the cost was from 10 to 20c. per bale for gas and lubricating oil.

A natural-gas engine installed at Elysian Fields, Texas, was run on 1,000 cu.ft. of natural gas per horsepower per hour, and the operating power cost was approximately 10c. per bale. A similar engine burning distillate at 8c. a gallon showed a cost of 17c. per bale for fuel and oil. In some instances gasoline is used; and many states return the tax on any gasoline used for industrial purposes. For the small gin this type of internal-combustion engine offers considerable economy.

Transformers Have Adjustable Inherent Reactance

TRANSFORMERS operating in parallel divide the load in proportion to their impedance and stubbornly refuse to alter this load division. Two large Westinghouse power transformers recently shipped to the Gulf States Utilities Company are designed with two different inherent reactances, to be adjusted for either at the will of the operator.

The transformers are rated at 9,383 kva., single phase, 60 cycles, 66 kv. high voltage, 13.2 kv. low voltage. The high-voltage winding has a parallel connection for 33 kv. They will be operated with 66- to 13.2-kv. and 33- to 13.2-kv., 3-winding transformers now installed. When the new transformers are operating with the 66- to 13.2-kv. windings of the old bank their impedance is 7.8 per cent, and when operating with the 33- to 13.2-kv. windings the impedance is 6.5 per cent.



Self-cooled two-winding transformers in which the reactance can be adjusted to allow operation on two different circuits

The change in impedance is obtained by a unique arrangement of the 13.2-kv. winding, which changes the length of the path of the flux that produces reactance, as well as its intensity, and depends only upon the connections made in the low-voltage winding. No reactors or auxiliary windings with circulating currents are used.

Two Motors Drive Belt Conveyor

By D. E. RENSHAW
Engineer
Westinghouse Elec. & Mfg. Co.

ONE OF THE many new features introduced in the Wildwood mine of the Butler Consolidated Coal Company, about 15 miles from Pittsburgh, Pa., is the slope belt-type conveyor used to bring the coal from the shaft bottom to the surface. This belt is designed for a continuous capacity of 750 tons per hour. The distance between centers of head and tail pulleys is 900 ft., and the belt is made of a 12-ply rubber composition 54 in. wide. On account of the weight of the belt and of the coal carried by it up an 18-deg. incline there is a large force tending to pull the belt back down the slope. It is therefore necessary to use a two-pulley drive, as in the diagram, to eliminate the possibility of the belt's slipping.

This type of belt is rather elastic and on reaching the first driving pulley it will be stretched appreciably. As the belt goes around this pulley the force acting on it is decreased and the belt contracts. Between the first and second driving pulley the belt is still stretched, but somewhat less than at the point of maximum pull, and as the second pulley is passed it contracts still further. Therefore it is necessary for the two driving drums to operate at different peripheral speeds under any given load. The differential between the speeds of the drums at varying loads will not be constant, because of the greater stretch in the belt at heavier loads.

Various methods were unsuccessfully tried to drive these two pulleys. One was to make the pulleys of slightly different diameter and to couple them rigidly together. Another was to gear the two pulleys together with a ratio which caused one to rotate slightly faster than the other. Both of these systems had the fault that they gave the correct speed ratios for one load only. For a heavier load the difference in speed was not great enough, and for a load less than normal the speed differential was too great. This resulted in excessive wear on the belt, increasing operating cost proportionately.

It was decided to drive each pulley by its own wound-rotor motor, without a mechanical coupling between the two pulleys. In this type of motor the speed decreases as the load increases. The rate of decrease in speed can be made greater by connecting resistance in the rotor circuit.

Taking advantage of these characteristics, a 250-hp. 587-r.p.m. motor was used to drive one pulley and a 75-hp. 585-r.p.m. motor was applied to drive the second pulley. At normal rated load the motors will operate with this fixed differential in speed. Resistance in the smaller motor's rotor circuit causes that motor to decrease in speed with increasing load more rapidly than the larger motor. Therefore, with increasing load on the belt, resulting in greater stretch, the difference in speeds of the two motors will be greater than two revolutions per minute. With a lighter load on the pulleys,

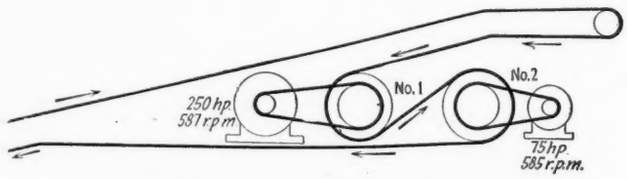
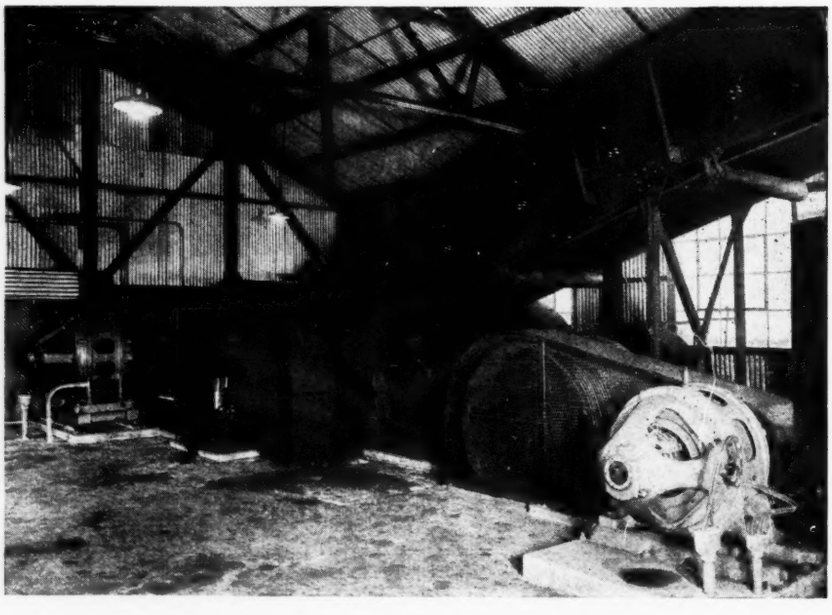


Diagram of belt-conveyor electrical differential drive in which two motors are used

resulting in decreased stretch, the difference in speed will be less than two revolutions per minute.

By adjusting the resistance in the rotor circuit, the two motors can be made to properly divide the load over a wide range. Consequently there is no tendency for the belt to slip on either pulley, with no unnecessary strains or wearing forces at any point. This arrangement is less expensive than any involving a mechanical connection between the two pulleys, and it is much less subject to rapid belt wear or to failure of any part of the system.

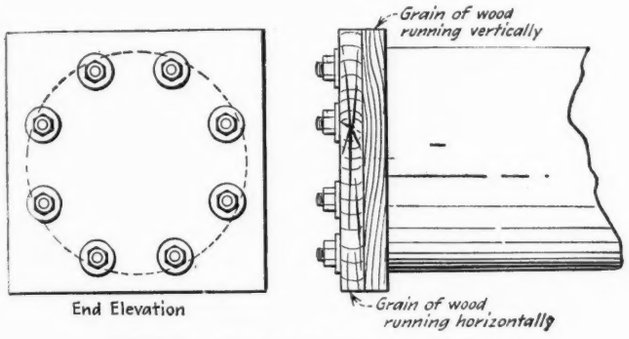


Motor room, showing a 250-hp., 587-r.p.m. and a 75-hp., 585-r.p.m. wound-rotor motor connected to belt conveyor. The belt is designed for a continuous capacity of 750 tons per hour. The distance between centers of head and tail pulleys is 900 ft.

...RIGHT OUT OF THE PLANT...

Emergency Cylinder Head for Steam Hoisting Engine

SOME YEARS AGO while in the employ of a gold mining company in Alaska, I was confronted with the breakdown of a hoisting engine, the cylinder head of which was blown off and broken in several pieces. The breakdown was considered serious at first because the property was situated far away from a base of supplies and also for the reason that there were few mining companies in Alaska that had proper facilities for making out-of-the-ordinary repairs. To send to the manufacturer for a new head would have required most of the time that was left of the season, which was five weeks.



Cylinder head made from two pieces of wood

One of the miners suggested that we put on a wooden head in place of the one broken. I made longer studs to make up for the increased thickness of the wooden pieces, two of which were used. The pieces were put together with the grain of the wood of one piece running vertically, and of the second piece running horizontally. The job was completed in less than three hours and operations were resumed.

RALPH E. MACKAY.

Butte, Mont.

Personnel Training Is a Big Factor in the Plant Betterment Program

A GREAT DEAL is being said and written today in regard to the foreman as a teacher. But isn't the point of foreman-teaching overemphasized, leaving the general feeling that he is the sole administrator of all caution and instruction that the new man receives?

This doctrine does not properly bridge the gap between management and workmen. The majority of foremen today have not the time to teach the new man all he should know. Granting that the foreman had the time to do all the teaching, would it be the last word in employee training? I have worked for highly efficient foremen, and yet I have been able to offer suggestions on improving certain operations which were eagerly accepted. The same holds true in thousands of instances in our industries. There is something wrong with a department where the foreman has to do all of the teaching. If none of his men is able to show him any new tricks or improved operations, the crew needs a culling.

Most workmen, feeling duty bound and working for their own interest, will advance a certain number of suggestions to their foreman. But how many are willing to advance suggestions to the new man, or wholeheartedly teach him the kinks that they have already learned through experience on the job? It is human nature for one not to relish the task of teaching himself out of a job. And this is the attitude taken by many workmen who feel they are not being given a fair deal. This fear for their jobs causes them to keep to themselves what would otherwise be valuable contributions to the department.

So there is a real factor in employee training that is too often disregarded: The foreman's task is training his men to think, and teach for him the minor details that consume his time. The first step in such a program is the establishment of confidence in each man that he is going to have an equal chance in the department's promotions.

Having taken a course in foremanship and industrial management under the guidance of an able teacher, I have, during the last two years, applied it to the men in my present department. It has meant the elimination of some, the encouragement and keeping close watch over others. So the main concentration on plant betterment has been personnel training. How this training is being carried out might be of interest.

It was the policy, until two years ago, to operate the electrical end of the plant as two distinct departments, operation and maintenance, with the result that the men in the operating department stayed there, working shifts, with no chance to learn or advance. This policy created a crew of stale operators, and held no attraction for an ambitious man. When a man was needed in the repair department he was obtained outside the plant.

The training program started with the giving of these operators a fair show at maintenance work. They were told that those who were willing to learn would be transferred to the maintenance department as openings occurred and conditions permitted.

With the drawing of the maintenance help from the operating department, assistant operators had to be taken on, and as they were later to become our repair men

we endeavored to select a better type of assistant operator than we had formerly. To give him the proper training, he worked every third week in the repair department.

During the last eighteen months it has been our practice to select the assistant operators from students of the local vocational training school. So far three students have joined the staff, and have somewhat surprised me in the work that they are able to do. They run conduit, do wiring, connect starters and motors along with the repair men.

One worked a night shift this summer so he could attend summer school. Now two of them are working the 4 to 12 p.m. shift, as operator and assistant, in order to make up high school credits for college entrance.

This allows the 4 to 12 p.m. operator to work in the repair crew, giving him more experience. It also gives him a chance to attend night school during the winter period.

The men's training has included safety first along with their other duties. Some twenty short safety talks have been posted in the department. When they are taken down they are filed in book form. When a new man comes into the department, he is given time to read them, to guide him in his work toward safety.

The safety idea has been followed in building up a set of operating rules, covering such duties as inspection, cleaning, oiling and care of motor belts.

To date two operators have been transferred to the maintenance department. In addition, I feel that the training program has given me better, safer operators.

Niagara Falls, N. Y. MARIN PHILLIPS.

Flooded Ammonia Systems

IN *Power* of Oct. 18, 1930, R. L. Shipman proposes to obtain a flooded ammonia system by feeding the coils at the top, which he cannot do, as the ammonia has to be fed in at the bottom. In going up, the gas will carry the liquor along with it and keep more of the coils wet with liquor. A trap or an accumulator is not necessary in the suction line to get the flooded system, though it is better to have a trap to insure against a freeze-back to the compressor. Oil will not flood on top of anhydrous ammonia liquor, for oil is about twice as heavy as ammonia. Any liquor in the system with the oil on top is more or less water, which should be drawn out of the system. Proper circulation of the brine takes care of the difference of temperature at top and bottom of the brine tank. B. E. RAMSEY.

Parsons, Kan.

Stoker Setting for Scotch Marine Boiler

REFERRING to the inquiry and answer on "Stoker for Scotch Marine Boiler," in the Oct. 21 number, a jointless, all-welded construction of water arch at the Cuneo Press Building, Chicago, by the Auburn Stoker Corporation, is shown in the illustration.

The installation of this water arch was advantageous inasmuch as it made it possible to install a stoker under a Dutch oven of a Scotch Marine boiler.

The arch enabled the boiler to be operated at 150 per cent rating, and increased the circulation within the boiler. No trouble has been encountered due to any leaks and the tubes have withstood the increased capacity to the satisfaction of the buyers.

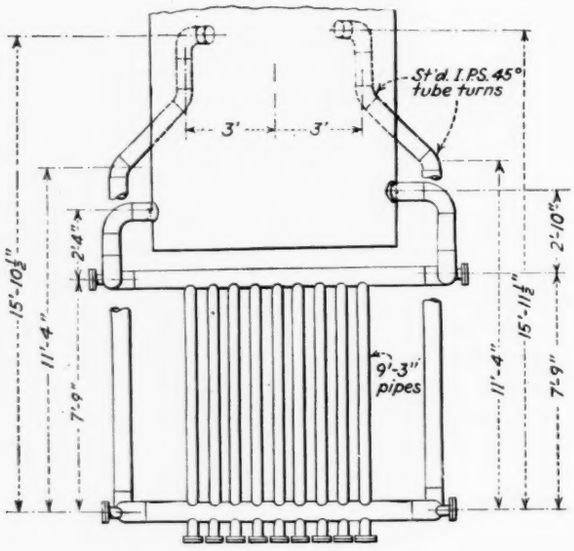
The construction includes nothing but straight pipe and tube turns, the latter being made of forged fittings especially designed for welded construction.

Welding nipples and flanged connections at points noted on the drawing permit of cleaning.

By use of the welding torch, provision can also be made to include side wall cooling as well as water arch construction.

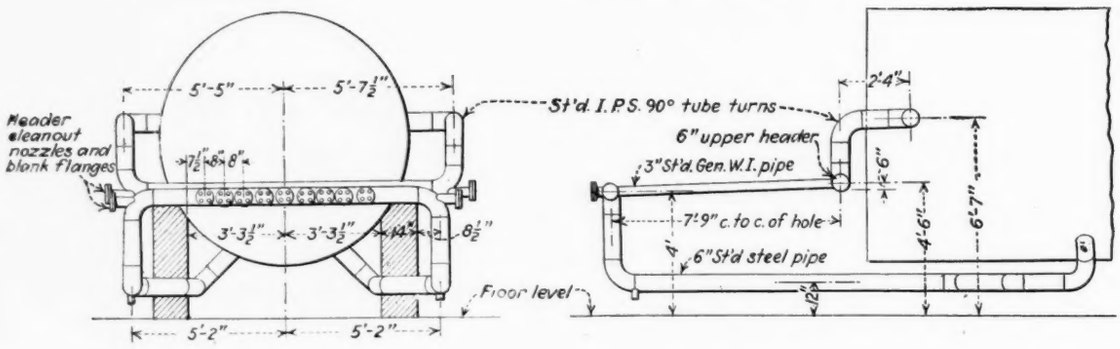
This setting has completely met all requirements of the Chicago Smoke Department, the installation being located in the heart of a congested industrial district.

Chicago, Ill. HARRY HIMELBLAU.



Plan of Water Arch

Layout of the water pipes forming the oven support



More Cooling Tower Data Needed

I NOTE the communication from M. C. Cockshott on page 943 of the Dec. 9 number on "Use of Spray Nozzles Increases Capacity of Cooling Tower." This article does not give any data as to the original condition of the cooling tower nor how much its capacity was increased.

It is reasonable to assume that the tower before the addition of the spray nozzles was either too small for its work or was of an inefficient type or it was badly out of adjustment.

A cooling tower, if properly designed, would cool the water close to the wet-bulb temperature, and in that case the addition of a spray nozzle system on top of the tower would be of no advantage.

The addition of the spray nozzles increases the load on the supply pump about 10 lb. per square inch. If the supply pump is of the centrifugal type, the quantity of water delivered would be decreased on account of the increased discharge pressure. The additional horsepower to pump 800 gal. per minute against 10 lb. pressure would be approximately 9, and it might be that the increased cooling effect of the spray nozzles in this particular installation did not save enough to justify the additional cost of pumping.

The foregoing is mentioned merely to show that the data given are not sufficient and therefore would not be of much value to anyone having a cooling tower problem of similar character. E. BURNHORN.

Bayonne, N. J.

Does Wetting Coal Improve Combustion?

IN THE Dec. 16, 1930, number, Charles G. Forbes of Medical Lake, Wash., wrote of his experience with wetted coal and the improvement in combustion that results from the wetting process.

The advantage was purely mechanical, and not chemical, as wetting the small particles in the slack caused them to agglomerate. If Mr. Forbes will repeat the experiment with well-screened pea or nut coal, either bituminous or anthracite, he will find no appreciable gain. After the fire has reached high combustion temperature, any water in the fuel is converted instantly to steam, which is dissociated by the glowing coals, carbon monoxide and hydrogen, or water gas, being formed. The hydrogen, if it passes over more highly heated carbon, picks up more carbon, forming gaseous compounds of the paraffine group, which are readily combustible if sufficient air be present. In either case the heat given off is exactly what was taken up in the endothermic reactions preceding. There is a loss in that each ounce of water taken in has to be heated to stack temperature. But the amount is so small that it is almost impossible to measure it, as errors in the calibration of the instruments used may wipe it out or put it on the plus side.

About thirty years ago I was an engineer in the Joplin, Mo., district, where Kansas coal was used. Like Pittsburgh coal, it is high in carbon and heat units and low in moisture, but has a high percentage of sulphur and ash, the former running as high as 5 per cent, which is equal to 10 per cent of iron pyrite in the coal.

My first experience in firing with this coal was a failure, as when I sliced it, I had to shut down, cool off and cut the clinker from the grates with a chisel. I found then that the custom was to let it lie, fishing out a clinker from time to time, but never stirring it; also to pipe the exhaust from the feed pump into the ashpit. After a number of experiments I found that the steam caused the clinker to form in little black pellets small enough to drop through the bars. These were magnetic, with strong sulphur reactions. The steam had simply reduced the ferric sulphide to ferrous—but why the form of small pebbles which looked as though worn by running water?

As Washington coal, like most of the Western coals, is comparatively free from sulphur, this method would not avail. Mr. Forbes is simply making little briquettes of his slack and improving combustion. Another possibility is that the steam changes a non-coking coal to a coking one, affording better combustion by agglomerating the fine particles and tar into compact lumps.

Cleveland, Ohio. L. R. BAKER.

Economy Needed in the Use of Heat

MUCH EFFORT seems to be directed toward improving the production and transmission of heat for building heating requirements. Although these factors receive attention, there is great laxity in conserving the heat after it is produced, and this factor seldom receives its due consideration. Some effort exerted in this direction will yield sizable savings.

The improvement of heating and air-conditioning practice and the methods of burning fuel have forged far ahead of the standards of ventilation as prescribed by city codes, and until these are altered to take advantage of the accomplishments of the heating and air-conditioning engineers, it seems useless effort for the latter to improve conditions at one end while waste is permitted at the other.

From time to time some excellent articles have appeared in *Power* describing means of making economical use of heat generated; nevertheless, heated air is thrown away and the heating of substituted cold outdoor air continues under the guise of ventilation.

Often, in industrial processes, large volumes of poisonous gases and offensive odors must be removed and uncontaminated air substituted for the protection of the occupants. In such cases recirculation of any of the air would always present an element of danger and should not be tolerated.

The discharge of exhaust ventilating fans from overventilated areas totals thousands of cubic feet of heated air per minute. Reclaiming this heated air by filtering, washing and purging it of impurities, to make it suitable for respiration, would be possible if city authorities concerned with ventilation took advantage of the developments of demonstrated merit in air conditioning and altered existing codes accordingly.

Cold outdoor air is desirable when the heat produced by people and lights is in excess of the amount required to offset transmission losses. When such a cooling problem is encountered cold outdoor air in sufficient quantity is an excellent medium to reduce the heat gain produced.

When ventilation codes are made to measure up to modern temperature, humidity, air motion and medical standards of cleanliness, much will be accomplished in conserving heat after it is produced, and operating methods that save money will be possible.

Brooklyn, N. Y. WILLIAM ANDERSON.

From Among Readers' Problems

Conducted by
L. H. MORRISON

TORSIONAL VIBRATION FROM INERTIA FORCES—*In* POWER *of Dec. 16, 1930, in an article on "Critical Speeds," the statement was made that the firing in the cylinders imposed periodic impulses on the shaft which might cause severe torsional vibration if the speed were high enough. Is this the only thing that can produce such vibration? How about inertia forces?* C.A.G.

It is true that inertia forces do set up impulses opposite to the firing impulses at each stroke of the piston. However, these forces, even in high-speed engines, seldom are greater than an equivalent 100 lb. per square inch of piston area, so that compared to the explosion or combustion pressures the inertia forces are not great. On the other hand, they occur four times as often in a four-stroke-cycle engine and twice as often in a two-stroke-cycle unit as do the explosions; consequently, they could set up excessive vibrations. The point was not raised in the article in question.

GAIN FROM REDUCING PRESSURE—*We are using 120-lb. steam in our lard kettles. What would be the fuel saving if this was reduced to 40 lb. by a reducing valve?* T.C.

Let it be assumed that no heat is lost by the steam line to the kettles, nor any lost from the condensate return line. It is obvious that all the heat given up by the steam in condensing goes into the process, no matter what may be the steam pressure. There might be an advantage in the use of 120-lb. steam, because it might increase the output of the factory.

If, on the other hand, the condensate from the kettles is trapped to the sewer, at the steam temperature, and still assuming that no heat is lost by the steam pipe, then the 120-lb. steam would not be as economical as the 40-lb. steam. At 120 lb. gage a pound of steam has had added to it 1,191.6 B.t.u., measured from feed water at 32 deg. F. The condensate at 120 lb. will have a temperature of 350 deg. F., and each pound will contain 321.7 B.t.u. Then, out of 1,191.6 B.t.u., 321.7 has been lost to the sewer, and 1,191.6 — 321.7 = 869.9 B.t.u. is given to the process.

If the 120-lb. steam is passed through a reducing valve, each pound will contain the same total heat as it had at 120 lb., namely, 1,191.6 B.t.u. But the condensate at 40 lb. has a temperature of 287.1 deg. F., and each pound will contain 256.3 B.t.u., which is lost in the sewer. The heat added to the kettles is then 1,191.6 — 276.3 = 935.3 B.t.u. This is 935.3 — 869.9 = 63.4 B.t.u. more than if the steam was used at 120 lb., and represents a saving of 63.4 ÷ 869.9 = about 7½ per cent in the fuel. That is, the total fuel bill will be reduced by 7½ per cent.

Feed water is usually above 32 deg. F., so the heat added to the steam from the feed-water conditions should be used rather than the heat from 32 deg. F.

It may be that the process is such that some of the heat in the condensate is given up, so that the condensate leaves the kettles at a temperature below that corresponding to the steam pressure. If so, this must be taken into account.

Other factors enter into the problem, but they cannot be used in these computations, as they are unknown.

It is possible that the existing line is so small that, due to the friction loss in the pipe, not enough steam at 40 lb. will reach the kettles. This can be overcome by setting the reducing valve at such a pressure that 40 lb. will be registered at the kettles.

ELEMENTS TO CONSIDER IN REPLACING MACHINERY.—*We are contemplating replacing our present steam plant with purchased power. In working up the comparative costs it has been argued that in the steam plant's operating costs should be included its fixed charges, as it has not been fully written off our books. Is this correct?* R.MCV.

The proper procedure is to set up two columns, one consisting of items eliminated through purchasing power, and the other the costs with purchased power. In the "elimination" column should be placed the operating costs of the steam plant, and in the second column the cost of the purchased energy, the labor item if any, and the fixed charges on the initial cost of the new equipment less the junk value of the old equipment. The fixed charges of the old equipment should not enter into the problem, for they are past history. If the savings brought about by the charge represent, say, 20 per cent on the new investment, the charge may be justified, although some industries demand a 100 per cent return on new equipment.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

HOW much acidity can I allow in the oil used for lubricating our 2,000-kw. impulse turbine without danger of corrosion or sludging? H.E.M.

THE ACID content of a lubricating oil may consist of inorganic acids, organic acids, or both. If an oil has an acid reading before it has been put into service, it is likely due to an inorganic acid that has been left in the oil as a result of improper refining methods. Such an oil is dangerous from the standpoint of corrosion and should not be used at all. For this reason I should prefer an oil which when new has a neutralization number of less than 0.05 mg. of KOH per cubic centimeter of oil.

If an oil tests acid-free when new, but shows a gradually increasing acidity with use, the condition is likely due to weak organic acids being formed by the oxidation of certain fractions of the oil itself. Such acids do not as a rule produce corrosion. However, their presence is a potential source of lubrication trouble, since they have a great affinity for water, with which they combine to form sludge. This fact is taken advantage of by various systems of turbine oil treatment which continuously expose a portion of the oil to pure water, thus effecting the formation and removal of sludge outside of the turbine system. Such a process keeps the acid content low, since it is removed almost as soon as formed.

On the other hand, in the absence of such treatment the acidity of an oil may build up as high as 4 or 5 mg. KOH per cubic centimeter of oil with no apparent ill effects so long as no water gets into the system. However, should water be suddenly introduced sludge may form in such quantity as to render the oil unfit for use. Such an occurrence may result in a shutdown, if not in serious injury to the machine.

Just how much acidity may be toler-

ated without risk seems never to have been positively established. It is known, however, that many modern turbine stations endeavor to keep the neutralization number below 1.0 mg. KOH per cubic centimeter. Three such stations I have in mind set the limit at 0.5, 0.8 and 1.0, respectively. Judging from this, a neutralization number of 1.0 should be a safe limit for the oil in question.

Withdrawing the oil when the acidity becomes too high does not necessarily mean that the oil is a total loss, as it may still be reconditioned or used on some machine from which oil cannot be reclaimed and which will not be endangered by the use of an inferior oil. If too frequent oil changing is required to keep the acidity down to a safe figure the installation of some system of oil treatment should perhaps be considered.

M. F. KNOY.

Beaumont, Texas.

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AS OUR company, National Acme, has been classed as having the largest machine shop in the world, covering twelve acres of ground, and because we build clarifiers and separators for crankcase, turbine, diesel and fuel oils, I think that I may speak with a certain degree of confidence.

If the oil be a straight or blended mineral oil, there need be no fear how much sulphur the oil contains. With a compounded oil, it is a different story, as the sulphur may be in some form like sulphonic acid, which in the presence of moisture and fatty acids from animal or vegetable oils will form a soapy compound, which while not harmful in itself may restrict the free flow to all parts needing lubrication.

Of all the erroneous ideas that persist, I know of none stranger than that of sulphur in oils. Most steel companies restrict the sulphur content of fuel oils to one-half of 1 per cent, and in lubricating oils to one-tenth of 1 per cent. In the former, the idea is that sulphur may attack the steel and make it hot-short. Anyone who has ever made ferrous sulphide has found that the iron must be white hot before it will combine with sulphur, yet textbooks still tell us that it is made by stirring melted sulphur with a red-hot iron rod. Try it once. Also, at that temperature the sulphur burns out with great facility, so it must be kept away from the air. Repeated tests at one large steel-casting plant have shown that high-sulphur fuel oils produce as low-sulphur steels as any. So too, with a hot bearing, make a thin paste of powdered sulphur and oil and apply it. This same mixture is used in cutting high-speed steels. A better way is to take a sulphur-base oil, which is a sulphonated fish oil carrying sulphur in solution, thinned with paraffine oil or distillate.

If I were in your questioner's place, I should take a number of four-ounce bottles and shake a mixture of the oil that it is contemplated to use, with an equal volume of distilled water (water softened with soda or borax will do) and compare the relative amounts of emulsion formed, which settles between the water and the oil. I suppose any oil representative will say that I am wrong, but remember that we do not sell or recommend any particular oil, but only furnish machines for reconditioning it. We meet all kinds of conditions and adopt methods to suit. We recommend a great many oils for use with our screw machines but for lubricating oils specify, "any good oil from a reputable refiner." On our Universal machine, which is a convertible separator and clarifier, is a brass plate reading: "Use automobile engine oil." We have found that either light or heavy oil will do, yet this little machine spins a six-inch cylinder at 10,000 r.p.m. and I have run it much faster experimentally.

L. R. BAKER.

Cleveland, Ohio.

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GOOD TURBINE OIL before use is free from acid, but during its use in the turbine becomes oxidized and develops acidity. This acidity should never exceed 2 per cent expressed as oleic acid, and to keep the acidity below this figure a certain quantity of the used oil must be drawn off and replaced with new, the quantity being determined by the acidity of the used oil.

Before use turbine oil should separate readily from an emulsion with water, but the addition of rust, iron hydroxide and salts carried over from the boiler by the steam can make the separation sluggish. In certain cases the water will not separate but will form a permanent emulsion, in which condition the oil is more readily oxidized owing to the greater area of oil in contact with water and its dissolved air or oxygen. The result of this oxidation is the formation of acid, which attacks the iron of the system and produces iron salts that form a permanent emulsion with oil and water. This, in turn, increases the oxidation of the oil and forms an acid sludge harmful to the turbine bearings.

Care and daily attention must be given to the lubricating oil supplies, pumps and attachments. Tanks should be opened periodically and scoured of scale and sludge deposits. No water sediment or oil mush (mixture of oil and water) should be allowed to collect in gravity or drain tanks or oil coolers, as oil mush can plug or seriously choke a feed pipe. Oil filters and magnetic steamers must be cleaned at regular intervals. Thrust bearings and flexible couplings should be inspected at frequent intervals to prevent gumming up of oil passages.

Analysis of the oil supplied should meet a standard specification and be rigidly adhered to.

Great care must be taken that no ordinary engine oil, which contains fatty acids, is added to the turbine oil. No water or vapor should enter the oil system. Samples of new oil should be kept for analysis. The whole system should be cleaned out at regular intervals with kerosene, and all foreign matter must be removed. To test for oleic acid, take 100 c.c. of benzote, petrol or alcohol, place in a stoppered measuring cylinder and add five c.c. of phenolphthalein. Into this drop one or two drops of $N/10$ solution of caustic soda until the phenolphthalein turns pink and remains so after shaking. Add 10 c.c. of the oil under test and shake gently. If the oil is acid the phenolphthalein, which collects at the bottom of the cylinder, will be colorless. Add $N/10$ solution of caustic soda, a drop at a time, and gently shake after each drop until the phenolphthalein turns pink.

The number of c.c. of $N/10$ caustic soda solution used multiplied by $0.28 \times \frac{1}{\text{S.G. of oil}}$ will give the percentage of oleic acid in the oil.

An $N/10$ solution means a tenth normal solution, which contains 4 grams of caustic soda per 1,000 c.c. of water. For example, if 10 c.c. of oil (0.88 S.G.) required 2 c.c. of $N/10$ caustic soda, the acidity would equal

$$\frac{2 \times .28 \times 1}{.88} = .63 \text{ per cent oleic acid.}$$

LESLIE W. ROSS.

Toronto, Can.

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A Question for Our Readers

WOULD you recommend electric welding of the seams of boiler drums where slight steam leaks occur, the boiler capacities and conditions being as follows: Steam pressure carried at 450 lb. gage; feed water temperature, 250 deg. F.; nominal horsepower, 1,000; average rating, 250 per cent? The longitudinal seams are double-strap butt joints, and double-riveted drum; heads are attached to the shell with double-riveted lap joints. The boilers are built in accordance with A.S.M.E. Boiler Code.

A.O.

Suitable answers will be published in the Feb. 24 number. They will be paid for either at the regular rate or by a choice of any one of the books listed below. (Indicate which book is desired.)

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkelsen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fittz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Ammett's *Electric Elevators*

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THE ENGINEER'S

Science in the Making

THE ADVENTURE OF SCIENCE. *By Benjamin Ginzburg. Published by Simon and Schuster, 386 Fourth Ave., New York City; 1930. Cloth, 6x9½ in.; 487 pages, illustrated. Price, $5.*

VIVID AND INTERESTING, this book is a dramatization of the development of science from Pythagoras to Einstein. Its story is richly interwoven with the lives and intellectual atmosphere of great scientists, for to portray science in the making is, as the author points out, to trace it as a human activity and relate its cultural values to those of other human activities. This does not mean, however, that the book suffers from too much "humanizing" or "popularizing" as works of this nature frequently do. On the contrary, though not dryly statistical, it is an authentic, high-spot record of progress in one of man's greatest fields of endeavor.

Starting with the first outstanding instance of disinterested scientific research—the birth of mathematics in ancient Greece — the story proceeds with the investigations and discoveries of Copernicus and Galileo during the Renaissance. Then on to Harvey's demonstration of the circulation of the blood, Newton's laws of mechanics and gravitation, the introduction of quantitative measurements in chemistry by Lavoisier, Dalton's atomic theory, the formulation of the laws of electrical phenomena by Faraday and Maxwell, Lamarck's and Darwin's theories of evolution, the biological investigations of Pasteur and Mendel and finally Einstein's theory of relativity and the quantum theory of Planck.

It is a fast moving and exciting story, this "Adventure of Science," and it is highly recommended to those who wish to broaden their knowledge of the history of science and extend their appreciation of its wonders.

Accident Prevention

SAFETY METHODS IN POWER-SYSTEM CONSTRUCTION. *Prepared by the Accident Prevention Committee, Engineering National Section, National Electric Light Association. Published by the National Electric Light Association, 420 Lexington Ave., New York City; 1930. Cardboard, 4½x6½ in.; 196 pages, 57 illustrations. Price to non-members $1.25.*

BECAUSE of the temporary nature of conditions that surround it, construction work is more susceptible to accident hazards than are completed installations. Eternal vigilance has been characterized as the price of accident prevention in plant operation, but it is even more so in plant construction. In this book the best methods of preventing accidents gleaned from a wide variety of experiences, are presented.

The work is divided into five parts: Accident analysis and prevention; construction practices; installation of machinery and equipment; power stations, and lines. Construction supervisors, foremen and others who realize, and desire to carry out, their responsibilities of providing safe working conditions and directing their men toward safe practices, will find many valuable suggestions in this handbook.

Material Standards

A.S.T.M. STANDARDS, 1930. *Two Volumes: Part I, Metals; Part II, Non-Metallic Materials. Cloth or half-leather, 6x9 in.; 1,000 and 1,214 pages, respectively; illustrations, charts and diagrams. Price: cloth, $7.50 for either volume or $14 per set; half-leather, $9 for either volume or $17 per set.*

A.S.T.M. TENTATIVE STANDARDS, 1930. *Paper or cloth, 6x9 in.; 864 pages, illustrations, charts and diagrams. Price: paper, $7; cloth, $8. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.*

ISSUED TRIENNIALLY, the A.S.T.M. Standards are recognized as authoritative in the field of engineering materials. The 1930 edition is published in two parts, Part I covering metals and Part II covering non-metallic materials. Contained in Part I are 179 standards relating to various metals used in the engineering fields. Of these 76 relate to steel, 9 to wrought iron, 11 to pig and cast iron, 8 to ferro alloys, 66 to non-ferrous metals and 9 to miscellaneous materials. Part II contains 251 standards: 39 relating to cement, lime, gypsum, concrete and aggregates; 22 to brick, refractories and tile; 36 to protective coatings; 23 to petroleum products and lubricants; 48 to road materials; 26 to waterproofing and roofing materials; 11 to rubber products and insulating materials; 15 to textile materials, and 31 to coal, coke, timber and miscellaneous materials.

The volume on tentative standards contains 155 standards which have been proposed for various materials and are printed for criticism and comment pending final adoption. Of these 12 relate to ferrous metals; 13 to non-ferrous metals; 16 to cement, lime, gypsum and clay products; 40 to preservative coatings and petroleum products; 25 to road and paving materials; 24 to rubber products, insulating materials and textiles, and 25 to coal and coke, shipping containers, slate and other materials.

Compressed Air Data

COMPRESSED AIR PLANT. *Fifth Edition. By Robert Peele, professor of mining engineering, Columbia University. Published by John Wiley & Sons, 440 Fourth Ave., New York City; 1930. Cloth, 6x9 in.; 511 pages, illustrations and tables. Price, $5.*

THOSE ENGINEERS who from time to time deal with air as a dynamic force, have generally turned to Peele's work for information not otherwise available. In this fifth edition, the author has brought the data up-to-date and consequently, has made the treatise more valuable. Unfortunately, in the stress of gathering the material, certain statements have been made that are by no means true. As an example, in discussing an engine the author states that "as air does not undergo condensation it follows that the lowest terminal pressure in the cylinder must be sufficiently above atmospheric pressure to produce a proper exhaust and to overcome the friction of the engine at the end of the stroke." Any engineer could point out that engine friction has no influence on the terminal pressure, save that the total work area must be great enough to care for the brake load and the friction. The terminal pressure depends upon the brake load, the initial air pressure and the cylinder dimensions. It is possible and is quite a frequent occurence that on light loads the terminal pressure is below atmospheric so that theoretically the complete expansion engine is possible—but practically it entails too large a cylinder for the slight gain in efficiency obtainable.

Judging from the amount of mathematics in the early chapters the volume is intended for engineers who are familiar with calculus. On this assumption, the author errs in indulging in such "popular engineering" as to state that in an air engine the lower mean pressure, compared to steam is due to the "development of cold during expansion . . . and the cold reacting on the expanding air reduces its pressure faster than that which is due to the increase in volume alone." This is not only poor engineering, it is also poor grammar. Other errors such as the statement that the mean effective pressure of a steam engine is affected by the reduced back pressure of the lighter atmosphere, should be corrected in future editions. The mean effective pressure is determined by the brake load, and for the same load is constant regardless of the back pressure.

Another remarkable statement is that "A short stroke is conducive to economy. With a long stroke the piston

BOOKSHELF

travels some distance under an increasing resistance; then, after the discharge valve opens, it completes its stroke under a uniform resistance, while adding nothing to the amount of useful work." In spite of such careless statements, which after all are indicative only of hasty rereading of the manuscript, the volume is the most thorough one on compressed air that is now available.

Turbine Text

STEAM TURBINES. *By T. M. Naylor. Published by Norman W. Henley Publishing Company, 2 West 45th St., New York City; 1930. Cloth, 8½x5½ in.; 207 pages, illustrated. Price $4.50.*

THIS VOLUME has been prepared to serve as a text in the study of steam turbines during the final year at engineering schools. It is written with the assumption that the student has a knowledge of thermo-dynamics, properties of steam, mechanics, and theory of lubrication.

The description and illustration of various turbine types is confined almost entirely to turbines of English and European manufacture, and does not therefore reflect American practice.

In addition to the material pertaining to turbine design, chapters on reduction gears, heat accumulators and condensers, have been included.

Rectifier Theory, Practice

MERCURY-ARC RECTIFIERS. *By Othmar K. Marti and Harold Winograd. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1930. Cloth, 6x9 in.; 473 pages, 15 tables, 230 illustrations. Price, $6.*

ALTHOUGH mercury-arc rectifiers date their beginning well back in electric-power history, it is within comparatively recent years that they have taken a prominent place in supplying large direct-current loads from alternating-current systems. At present metal-clad rectifiers are built for current up to 16,000 amp. Their applications are expanding rapidly, which makes a book like this on their theory and practice a desirable contribution to engineering literature.

A tremendous mass of material has been contributed on the theory, design, operation and application of mercury-arc rectifiers. In the appendix a bibliography lists 436 contributions, dating from 1882 to the present year. However, few attempts have been made to co-ordinate this information in a form where it is readily available. This volume, covering both the theory and practice, supplies a need among operating, designing and consulting engineers.

The first three chapters deal with historic development and elementary principles of rectifications. These are followed by three chapters that are highly mathematical on the theory of the rectifier and rectifier transformers. The last eight chapters are practical, and treat of design, construction, operation, application and testing of mercury-arc rectifiers and their auxiliaries. The book is so arranged that, without destroying the continuity of the treatment, the chapters dealing with the mathematics of rectifiers may be omitted by those readers interested in the practical side.

Our Oil Supply

OIL CONSERVATION AND FUEL OIL SUPPLY. *Compiled and published by the National Industrial Conference Board, 247 Park Ave., New York City; 1930. Cloth, 6x9 in.; 165 pages, charts and tables. Price, $2.50.*

THIS VOLUME deals with the past history and present status of the oil supply of this country. Containing as it does much data on the production, distribution and use of fuel oil and its derivatives, those who are in need of such statistics will find the book of value. Occasionally small errors have been permitted to creep in—such as the statement that a greater efficiency is obtained from oil and gas than from coal. The compilers probably forgot the loss due to the hydrogen content, for actually a coal-burning furnace will show an efficiency several per cent above that theoretically possible with oil or gas.

In spite of the amount of time spent upon the data no solution of the conservation-of-fuel problem is offered—probably because none can exist other than the one of supply and demand.

Brief Reviews

TRANSACTIONS OF THE TOKYO SECTIONAL MEETING OF THE WORLD POWER CONFERENCE. Three volumes, 3,500 pages, illustrated; price, $40. TRANSACTIONS OF THE BARCELONA SECTIONAL MEETING OF THE WORLD POWER CONFERENCE. Two volumes, 2,800 pages, illustrated; price, $20. Both sets distributed by the American Committee of the World Power Conference, 1419 Chrysler Building, 405 Lexington Ave., New York City.—Complete general reports, discussions and papers presented at the two World Power Conference sectional meetings held in 1929.

THE FEDERAL POLYTECHNIC SCHOOL, ITS INSTRUCTION AND INSTITUTIONS. Published by Orell Fussli Verlag, Zurich, Switzerland. 126 pages, illustrated; price, 3 francs.—A guide compiled by the faculty of the famous École Polytechnique Fédérale at Zurich on the occasion of its 75th anniversary for the purpose of explaining the aims, methods of instruction and courses of study of the school.

HYDRO-ELECTRIC DEVELOPMENT IN SWEDEN. By Erik Upmark. Published by the Swedish Water Power Association, 16 Norrlandsgatan, Stockholm, Sweden. 130 pages, illustrated; price, 3 kroner.—A short and comprehensive description of the Swedish water-power industry.

CHARGES AND METHOD OF MAKING CHARGES FOR PROFESSIONAL SERVICES. Bulletin No. 5, 56 pages. CHARGES FOR ENGINEERING SERVICES. Bulletin No. 6, 11 pages. Both compiled and published by the American Society of Civil Engineers, 33 West 39th St., New York City.—Studies of a special committee of the A.S.C.E. for the purpose of formulating principles for the determination of engineering fees.

A CALORIMETRIC DETERMINATION OF THERMAL PROPERTIES OF SATURATED WATER AND STEAM FROM 0 TO 270 DEG. C. By N. S. Osborne, H. F. Stimson and E. F. Fiock. Published as Research Paper No. 209 by the Bureau of Standards; 70 pages, illustrated. For sale by the Superintendent of Documents, Washington, D. C.; price, 20 cents.—Results of a study undertaken to extend steam-table data to meet present and prospective demands of steam-power engineering.

N.E.M.A. MOTOR AND GENERATOR STANDARDS. Publication No. 30-2 of the National Electrical Manufacturers Association, 420 Lexington Ave., New York City. Paper; 132 pages, charts and tables; price, $1.50.—A reference work of practical information concerning the manufacture, test and performance of alternating- and direct-current motors and generators.

BRITISH ENGINE TECHNICAL REPORT FOR 1929. Published by the British Engine Boiler & Electrical Insurance Company, Ltd., 56 Kingsway, W.C.2, London, England. Paper; 209 pages, illustrations, charts and tables; price 7s.6d. —A report of investigations of accidents due to the failure of boilers, turbines, steam and oil engines, generators, motors and other power plant equipment.

Causes of "Pumping" In Steam Turbine Governors

Instances are on record where, after a system disturbance, the turbine governor beams oscillated until some means was taken to correct the condition. Tests made to determine the reasons for this phenomenon show that it is produced by the generators pulling out of step and then re-synchronizing *

IN THE last few years the amount of analytical and test work on system disturbances and stability has increased tremendously, but very little of this theoretical or practical activity has dealt with the operation of steam-turbine governors. Therefore when field tests appeared advisable to determine the cause of trouble evidenced by overspeeding and consequent tripping of the emergency overspeed governors on the two 50,000-kw. single-cylinder reheat-type turbines at the Stanton steam plant during the lightning seasons of 1928 and 1929, this opportunity was used to make an investigation of the operation of turbines during system disturbances.

The plant is located near Pittston, Pa., and is jointly owned by the Scranton Electric Company and the Pennsylvania Power & Light Company. The steam connections and valves of the turbine are shown schematically in Fig. 1. All governing is normally done by the main control valve at the first stage of the turbine. Each generator has its own transformer bank and 66-kv. bus. Power is normally supplied by generator No. 1 to the Scranton Electric Company, and by generator No. 2 to the Pennsylvania Power & Light Company. The 66-kv. busses are tied together through a bus-tie reactor. Because of this reactor, generator No. 1 tends to swing with the Scranton Electric system and generator No. 2 with the Pennsylvania Power & Light system.

Load Transfer Tests

Several operating companies have reported that during certain system disturbances the governor beams of their turbines have oscillated for two or three minutes or until some means was taken to correct the condition, such as holding the governor beam, or disconnecting the turbine from the system. This phenomenon has generally been termed "governor pumping" and should not be confused with governor hunting, which is a slow, periodic movement caused by lag of the valve behind the governor.

Inasmuch as little adequate data were available on governor pumping and because it had appeared in one of the tests, attempts were made to reproduce the phenomenon for the purpose of recording and analyzing this disturbance.

Load transfer tests were first made to determine if governor pumping could be produced by a disturbance of minor magnitude. By opening the bus-tie breaker it was possible to suddenly increase or decrease the load on generator No. 1 as much as 20,000 kw., but it was impossible with load-transfer tests to obtain a sustained oscillation.

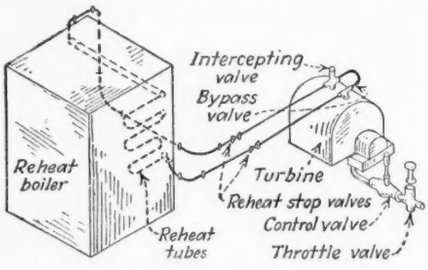


Fig. 1—Diagram of piping and valves of Stanton turbine

Next, a test was made to see if it were possible to start a sustained oscillation by suddenly disconnecting the generators from all loads, but not from each other, when they were carrying unequal portions of the load. Generator No. 1 was loaded to 30,500 kw. and No. 2 to 10,000 kw., and then the oil circuit breaker to the load was tripped. Generator No. 1 dropped to 5,000-kw. load as a generator and No. 2 took 5,000 kw. as a motor. At the same time the two generators increased in speed until they tripped the emergency overspeed governors. No oscillation of any magnitude was obtained either in the kilowatt output of the generators or in the movement of the governor beams.

In another test the governor beam was slowly pressed down until the load on generator No. 1 was reduced from 40,000 kw. to 22,000 kw. The governor beam was then released and the generator picked up its previous load of 40,000 kw. without any appreciable oscillation of the governor beam or kilowatt output.

From this series of tests it was concluded that it would be impossible to set up a sustained oscillation in the governor equipment without a much more severe system disturbance. Therefore, two conductor-to-ground short circuits were made in an effort to reproduce the pumping previously noted. These tests were successful in reproducing the phenomenon. The record used as a basis for analyzing the governor pumping was a two conductor-to-ground short-circuit test in which the generator lost synchromism but did not trip the emergency overspeed governor, so that the speed governor still controlled the steam input. The reduction in the generator output due to the loss in synchronism, coupled with the normal speed-regulating characteristics of the governor, resulted in a sustained prime mover speed above that of the system.

Results of Tests

Fig. 2 shows the results of this test. During the first 2.5 sec. the movement of the main control valve was controlled by an auxiliary pilot valve which was being used in a preliminary form in an attempt to keep the turbine in synchronism; the pilot valve, however, had no effect on the governor or control valve after this initial period. Seven seconds after the short circuit occurred the governor mechanism started to oscillate at a period coinciding exactly with the kilowatt oscillation of the generator. The speed curve shown is composed of an average speed curve obtained from the oscillograph record and a superimposed speed change calculated from the output of the generator and added to the average speed curve. From this composite curve it can be seen that if the governor follows the speed of the turbine it must alternately open and close the control valve an

*Abstract of a paper "Governor Performance During System Disturbances," by R. C. Buell, R. J. Caughey and E. M. Hunter of the General Electric Co., Schenectady, N. Y., and V. M. Marquis, American Gas & Electric Co., New York City, presented at Southern District Meeting No. 4 of the American Institute of Electrical Engineers, Louisville, Ky.

appreciable amount. The curves show that the governor was doing its best to follow these speed changes, although with about a quarter-second time lag, and was thus varying the steam input in accordance with the speed, which is exactly what a speed governor is designed to do.

About eight seconds after the occurrence of the short circuit the speed of the turbine was approximately 1,860 r.p.m. with a periodic plus and minus speed variation of 15 r.p.m. This 30-r.p.m. speed change at the average speed of 1,860 r.p.m. calls for a control valve stroke of about 1.3 in. Fig. 2 shows that the stroke of the control valve at this time was about 1.3 in., and the average position was about correct for the average speed.

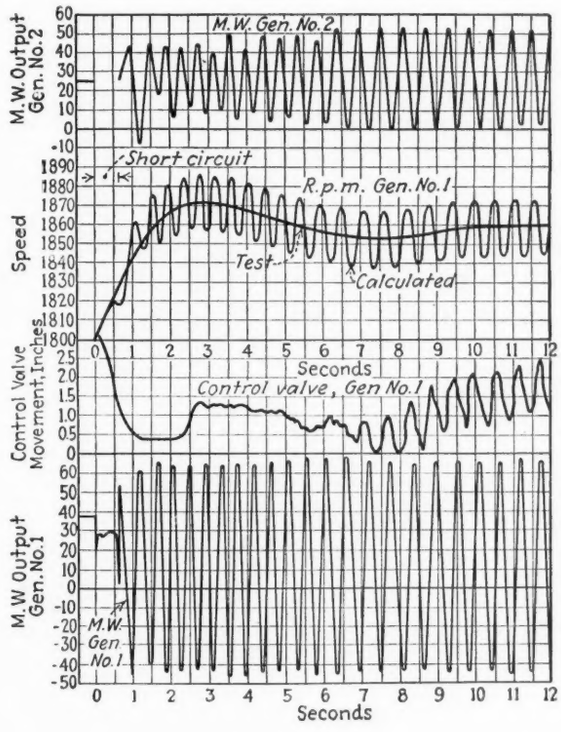


Fig. 2—Results of one test that caused pumping of the turbine governor and control valve

During the interval from the third to the seventh second the periodic speed change caused by the generator slipping poles was so fast that it was impossible for the control valve to follow it. However, as soon as the average turbine speed came down to a point where the governor mechanism and control valve could follow the periodic changes in speed, the control valve started a pumping movement in which it assumed the proper position corresponding to the speed. This pumping of the governor beam was therefore a normal action and should be expected under conditions such as existed at the time of its occurrence.

During the period that the governor beam was oscillating in synchronism with the kilowatt oscillation of the generator, the speed of the generator was about 1.8 cycles above the speed of the system. This represents a slip frequency of 108 cycles per minute. The natural period of oscillation of the governor weights and springs, without the frictional resistance of the pilot valve and oil system, is about 200 cycles per minute. Due to this difference in natural period of oscillation, it seems reasonably sure that the governor mechanism itself contributed nothing to the oscillation of the governor beam and control valve. The speed change must be considered at least the primary cause of the oscillation or pumping.

An effort was made to stop the pumping of the governor beam by steadying it by hand; the oscillation itself was damped by this means, but the turbine did not slow down and re-synchronize, due to the fact that no reduction was made in steam admission. The turbine was finally pulled into synchronism with the system when the main throttle valve was closed by hand, allowing the turbine to come down in speed. Considerable oscillation had been noticed in the meantime on generator No. 2, and it was removed from the system by tripping the generator oil circuit breaker.

There are two ways of remedying governor pumping after it has started. The first method, which may be preferred in many instances, is to reduce the speed of the turbine so that it will synchronize with the rest of the system. The second method is to remove the generator from the system by tripping its oil circuit breaker. The operator in the switchboard gallery can apply the first method by operating the synchronizing motor on the governor spring, and the second method by tripping the generator oil circuit breaker. The turbine man can also apply the first method by tripping the throttle valve. This valve, however, should be re-opened the instant the generator pulls into synchronism, to avoid burning the turbine blades. As the turbine speed will decrease rapidly when the throttle valve is closed, the generator will usually re-synchronize by the time the turbine man is ready to re-open this valve.

Previous investigations of governor pumping have shown that it was apparently possible to damp out such oscillations during some tests by merely introducing frictional resistance on the governor beam, but during other tests this method was not successful. In all previous investigations it had been possible to set up governor pumping only by some severe system disturbance, which in all probability meant that the generator was out of synchronism with the rest of the system. The results of these previous investigations also suggest that the primary cause of governor pumping is loss of synchronism and consequent periodic speed change of the generator involved when it slips poles.

If the regulation of the turbine governor from no load to full load is small, the slip frequency when the generator is out of step will be low, consequently a relatively long time is available to alternately store and take energy from the rotor. This will result in a large periodic change in speed at a low frequency which can be easily followed by the governor, and will cause the control valve to move over a wide range. If the regulation is increased, the speed at which the turbine will run when out of synchronism will be higher, the slip frequency between the generator and the rest of the system will be greater, and the speed change as the generator slips poles will be less. All of these factors tend to reduce the effect on the governor and make it more difficult for it to follow the periodic speed changes due to pole slipping. This may explain why it has apparently been possible to cure some cases of governor pumping by merely broadening the regulation range of the governor.

Reducing the field of the generator, as has been done in some previous tests, would also tend to reduce the magnitude of the periodic speed change as the generator slips poles, and consequently reduce the effect on the governor.

Conclusions

From this series of tests the following facts seem to be evident:

1. The turbine governors operate correctly under all normal conditions of load transfer and system disturbances as long as the generators remain in step with the rest of the system.

2. Pumping of the governor mechanism occurs primarily because of a periodic change in speed of the turbine.

3. Pumping of the governor mechanism may continue indefinitely if the generator loses synchronism and the steam input is not cut off.

4. Pumping will terminate if the generator is synchronized with, or segregated from, the system. Synchronization may be expedited by cutting off the steam input to the turbine so that its speed will be reduced and again match that of the system.

Standard Control-Cable Color Code Approved

By G. SUTHERLAND*

Chairman N.E.L.A. Electrical Apparatus Committee

A STANDARD for colored control cable has been approved by both the National Electric Light Association and the National Electrical Manufacturers Association. A joint committee of these associations prepared this standard after a review of questionnaires sent to 26 American utility companies and after a study of comparative tests conducted by this committee.

When all manufacturers are able to standardize on a uniform national colored control cable specification, better deliveries, less construction delay and more uniform prices will be secured for the industry.

The questionnaires sent to the operating companies disclosed present-day practice, while the comparative tests removed many of the troublesome color combinations still found on some systems. The standard is therefore based upon the combination of current practice and operating experience. It is not feared that a great deal of trouble will develop when fitting this new color scheme into old color systems, because the standard contains the basic features now utilized by twenty leading operating companies in this country.

In determining the arrangement of the colors, it was considered advisable to assign those most commonly used to the lower numbers. Thus a 5-conductor braided cable, for example, will employ the first five colors: black, white, red, green and orange, as in Table II. For a 37-conductor cable, the cable will utilize all the color combinations available. In the interest of uniformity it should be noted that the order arrangement of the basic colors is also utilized in the tracer development.

TABLE I—STANDARD COLOR SPECIFICATION NUMBERS

	No.		No.
Black	.....	Green	60,105
White	60,001	Orange	60,039
Red	60,068	Blue	60,079

The comparative tests consisted of deliberately soiling two sets (A and B) of differently colored samples with dirt, grease and oil to approximate the worst conditions usually found around switchboards. Set A was a scheme using a 50 per cent distribution of colors for two-color combinations and a 33⅓ per cent distribution for three-color combinations. Set B consisted of the regular basic colors with one or two tracer stripes. Each set was jumbled up in one heap. Maintenance men and installers were asked to pick out and arrange the cables in the order of Table II, each complete operation being timed for each man. The lighting was also changed from good daylight to average artificial lighting as found behind switchboards and in vaults or manholes.

It was discovered that such hues and color combinations as brown, violet, blue and black, yellow and white, green and blue, green and black, green and lavender do not readily show up their identity under poor artificial lighting. The men would invariably pause over these colors and require a longer time than when picking out the more pronounced hues. Tests on orange and yellow colors proved that the orange was the most distinctive. The most troublesome color combination for the men to pick out was a cable using green with a blue tracer. Each man insisted that he found only one color until he discovered he had an odd cable left over when he came to the end of his table.

Time comparison tests on clean cables were also conducted. When picking out colors under set A, the 50 per cent color combination group, it was found that considerable trouble was experienced. There being no predominating color to use as a base guide, the eye required a longer time to grasp the color distinction than in set B, which employed a base color and a tracer stripe. In the latter case the men would look first for the solid base color and then pick out the tracer. The men expressed a preference for the tracer stripe; they claimed it was much easier to pick out the colors.

Another important reason for choosing the tracer stripe was the ease in expanding the color group above 21 conductors. If the 50 per cent color system were employed, and three colors were desired for future cables, it would be necessary to employ a 33⅓ per cent color division in the braid. In the tests with this scheme, the men complained the zig-zag appearance of the braid made them believe their eyes were crossed. They complained about seeing wavy lines in the cable, which confused them in picking out the three colors so closely woven. This system furthermore limited the conductors to less than forty. While using a tracer-stripe method the manufacturers are able to make a cable having 100 separate and distinct color combinations. Hence the 50 per cent 33⅓ per cent color system was discarded in favor of the tracer-stripe method.

Once the colors desired were determined it became necessary to set up a definite standard for securing the exact hue and shade. Use was made of the standard color card issued by the Textile Color Card Association of the United States, 200 Madison Ave., New York, N. Y., which is accepted as a standard throughout the textile field. This card definitely assigns a specification number to each of the 200 different hues. The joint committee studied this card and picked out a definite specification number for each of the five chosen basic colors, white, red, green, orange and blue, thereby automatically requiring all colored control cable manufactured in various parts of the country to be uniform in hue. By specifying a single number for each color there will be less trouble in the field when matching colors of cables installed at various times and purchased from different manufacturers. If alternative numbers had been included as a choice, it would be difficult to imagine the confusion in manufacture and in use. To avoid such confusion only one identifying specification number was chosen. The numbers in Table I were chosen from the textile color cards.

Another important element requiring a rigid specification was the definite determination of the width for the tracer stripe. If only one carrier thread were used, it soon became indistinct when soiled. Two threads improved the distinction somewhat, but three carrier threads were found to be preferable. Hence, it was written into the specification that "the tracer stripe shall consist of three carriers." On cables above 21 conductors another tracer stripe, also three carriers wide, is to run crossing the first stripe. The distinct choice of three carriers to form the tracer stripe avoids a possibility of confusing faded or dirty stripes, which would occur if only one colored carrier were used.

TABLE II—STANDARD COLOR SYSTEM FOR CONTROL CABLE SPONSORED BY THE JOINT N.E.L.A.[1] AND N.E.M.A.[2] COMMITTEE

Base	Tracer	Tracer
1—Black		
2—White		
3—Red		
4—Green		
5—Orange		
6—Blue		
7—White	Black	
8—Red	Black	
9—Green	Black	
10—Orange	Black	
11—Blue	Black	
12—Black	White	
13—Red	White	
14—Green	White	
15—Blue	White	
16—Black	Red	
17—White	Red	
18—Orange	Red	
19—Blue	Red	
20—Red	Green	
21—Orange	Green	
22—Black	White	Red
23—White	Black	Red
24—Red	Black	White
25—Green	Black	White
26—Orange	Black	White
27—Blue	Black	White
28—Black	Red	Green
29—White	Red	Green
30—Red	Black	Green
31—Green	Black	Orange
32—Orange	Black	Green
33—Blue	White	Orange
34—Black	White	Orange
35—White	Red	Orange
36—Orange	White	Blue
37—White	Red	Blue

[1]Accepted by N.E.L.A. Electrical Apparatus Committee at Virginia Beach, May 19, 1930.
[2]Accepted by N.E.M.A. Power Cable Group at New York, Aug. 28, 1930.

*New York & Queens Electric Light & Power Company.

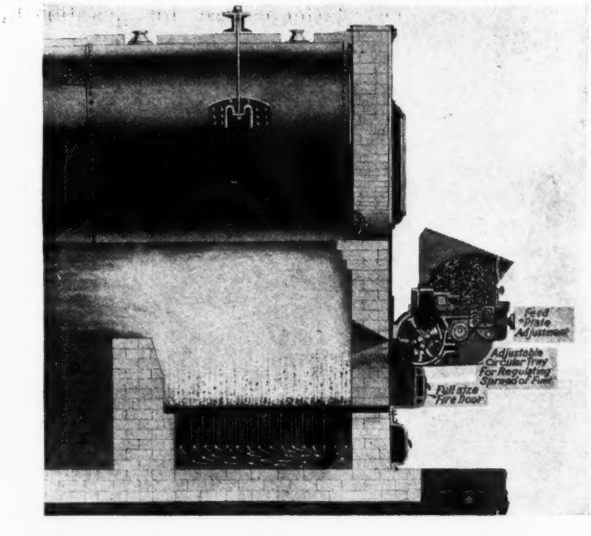
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Automatic Stoker With Revolving-Type Distributor

IN THE accompanying illustration is shown an automatic stoker of the revolving-blade type that may be adapted to firebox, fire-tube, water-tube and Scotch marine boilers, in sizes ranging from 500 to 10,000 sq.ft. of heating surface.

As will be apparent from the illustration, there are no moving parts inside the combustion chamber, the entire stoker-operating mechanism being mounted directly on the boiler front. A full-size hand-firing door is incorporated in the front plate, and a full-size grate area is used, thus permitting the boiler to be hand-fired in an emergency.



Stoker-operating mechanism is mounted directly on boiler front

The stoker is simple in operation. Coal feeds by gravity from the hopper to a reciprocating feed plate which discharges it to a curved adjustable throat piece, where it is picked up by revolving distributor blades and spread over the entire grate surface. The speed of the distributor blades is constant, the blades, together with the circular tray, being set for particular lengths and widths of furnace, and requiring no further change in operation. The only adjustment required for changing loads is the stroke of the feed plate. This is effected by a small handwheel at the front. Adjustment can be made for coal feeds from 1 to 60 lb. of coal per square foot per hour. The blades of the distributing mechanism are hinged, being held in position by centrifugal force only, when the stoker is in operation. This feature prevents damage to the stoker from foreign matter entering with the coal. The blades when swung back will clear to the extent of 3.5 inches.

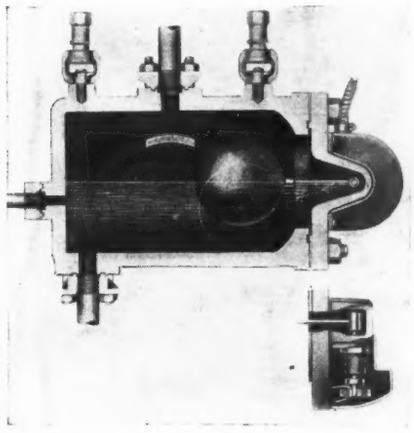
The operating mechanism is equipped throughout with roller bearings and high-carbon steel shafting. The distributor blade shaft bearings which are exposed to the radiant heat of the furnace are water-cooled.

An important feature of the stoker is tuyère plates of special design that make up the grate surface. It is claimed by the manufacturer that, owing to this special arrangement, air for combustion is preheated and injected through the fuel bed through angularly placed openings, causing a criss-crossing of air jets and effecting a thorough mixing of the air and gases. The area of the tuyère opening and length of tubes are predetermined for various classes of fuels and conditions. It is also claimed that the use of the extended cooling surface or tubes on the lower side of the grate tends to keep the plates at a safe temperature under all ratings. Forced draft is supplied beneath the grate by a slow-speed, direct-connected, motor-driven blower at the side of the furnace. The stoker is put out by the Hoffman Combustion Engineering Corporation, 410 Ford Building, Detroit, Mich.

Liquid-Level Control for Refrigerating Evaporators

ALTHOUGH designed primarily for use with the Grinnell unit cooler described in the November 18 number of *Power*, the liquid-level control illustrated is suitable for use with pipe coils, direct-expansion coolers, brine coolers and similar equipment.

The control is operated by a steel ball float riding in the liquid. The float, in turn, operates a mercury contact switch controlling the current to a solenoid valve in the liquid-supply line leading to the control chamber. A safety feature incorporated in the control is that the supply line is opened only when the valve solenoid is energized. In event of current failure the valve remains



Section of liquid-level control and detail of mercury contact switch

closed and prevents the liquid's going above the desired level.

The control, which is put out by the Grinnell Company, 260 West Exchange St., Providence, R. I., is suitable for use with the various refrigerating liquids, such as anhydrous ammonia, sulphur dioxide, menthyl chloride, etc., and practically all types of refrigerating evaporators.

Gasoline-Oxygen Cutting Torch Unit

USE OF KEROSENE instead of acetylene features a new line of metal cutting equipment put out by Torchweld Equipment Company, Chicago, Ill.

Instead of the usual acetylene storage tank placed alongside the oxygen cylinder, a 2-gal. gasoline tank is mounted at the rear of the oxygen tank, as shown in the illustration. This, in addition to giving considerable reduction in weight, requires a much smaller truck, thus facilitating movement of the unit from place to place.

The new unit consists of cutting torch with four gasoline cutting tips, 25 ft. of high-pressure oxygen hose, 25 ft. of flexible metallic gasoline hose, a 2-gal. gasoline tank, a high-pressure regulator and other auxiliaries.

Gasoline cutting torch unit, with enlarged view of torch

Instrument for Measurement of Sodium Sulphate in Boiler Waters

BASED upon the Parr sulphur photometer, an instrument designated "turbidimeter" has been developed by the Burgess-Parr Company, 111 West Monroe Street, Room 1801, Chicago, Ill., to provide a ready means of measuring the sodium sulphate in boiler waters, which is of importance in guarding against caustic embrittlement. It can also be used in the analyses of fuels for sulphur, being an accessory, in that

How the turbidimeter is used

instance, to the oxygen bomb calorimeter, the peroxide calorimeter or the sulphur bomb.

The instrument consists of a bakelite-walled container having an optical glass bottom, a plunger tube of similar construction, a mechanism for altering the distance between the bottoms of the two tubes, and an eye-piece tube using a soft rubber shield, all mounted upon a metal base containing an electric filament lamp with a rheostat and voltmeter for controlling the lamp voltage.

In operation, the turbid solution (produced by adding barium chloride crystals to the boiler water or oxygen bomb washings) is poured into the containing tube. The plunger tube and eye-piece tube are set in the proper position, the electric lamp is regulated at the proper voltage and, by means of a gear-and-rack mechanism, the plunger tube is raised until the filament of the lamp can no longer be seen from the eye-piece. The reading in millimeters of solution is then made from the scale, and by referring to a chart provided with the instrument the quantity of sulphur or sulphate can be determined. Check determinations can be made in a few seconds.

It is pointed out by the manufacturer that a complete determination of sodium sulphate in boiler waters can be made within three or four minutes, and the same speed can be obtained in making sulphur determinations from oxygen bomb washings or peroxide bomb fusions.

Manual Starter With Push-Button Reset

ONE OF THE features of the Class 2510 manual starter brought out by the Industrial Controller Division, Square D Company, Milwaukee, Wis., is that all poles are simultaneously opened with the tripping of either of the two relays. The thermal overload relay is the standard type used in the regular line of automatic starters put out by the company.

Another feature of the starter is its trip-free handle, which prevents blocking of the switch closed against an overload. As the starter is operated entirely from the front, a number may be mounted in pairs or groups on pedestal or wall without waste space. The starter is reset for operation by

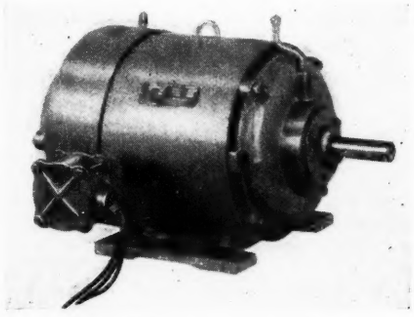
Starter has trip-free handle and push-button reset

pressing the button extending through the front cover.

The three phase ratings are 5 hp., 220 volts and 7½ hp., 440 and 550 volts. It is suitable for pumps, portable conveyors, fans and any application where low-voltage protection is not required.

Totally Inclosed Fan-Cooled Motor

A SEALED motor easy to take apart and reassemble has been produced by the Louis Allis Company, Milwaukee, Wis. Known as Type J, the new unit is a modification of the Type R motor and utilizes similar methods of inclosing and ventilating. Additional refinements include "cartridge-type" bearing chambers and simple devices for removing the fan, ventilating shell and heads quickly.



Allis Type J totally inclosed motor

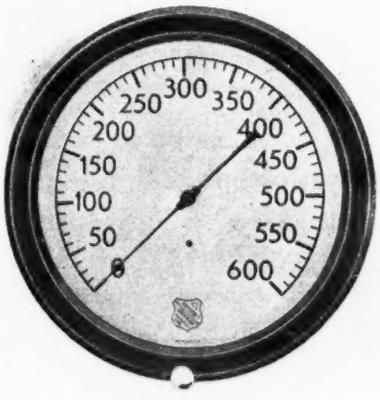
Type J is a totally inclosed motor sealed inside a sheet-steel ventilating shell. All inclosing parts are joined by long close all metal-to-metal fits. All bearing chambers are within the inclosure, thus utilizing the oil seals and fits of the cartridges around the shaft to exclude foreign matter. The back bearing may be inspected without disturbing the fan guard, fan, or rotor. The motor is available in sizes of 3 to 100 horsepower.

Gage for High Pressures and Temperatures

DEVELOPED especially to withstand the high steam pressures and temperatures now in use, as well as severe vibrations and pulsations in service, the pressure gage illustrated, with special movement of nitralloy steel, has been introduced by Consolidated Ashcroft Hancock Company, Inc., Bridgeport, Conn.

The tube is bored out of special solid steel alloy, which, it is claimed, gives uniform expansion and contraction throughout the entire range of the gage. The sockets are made of forged steel, and the cases are die-cast and usually furnished with black hard-rubber finish. The pointer has an integral micrometer adjustment which makes it simple to compensate the gage for water leg in the field.

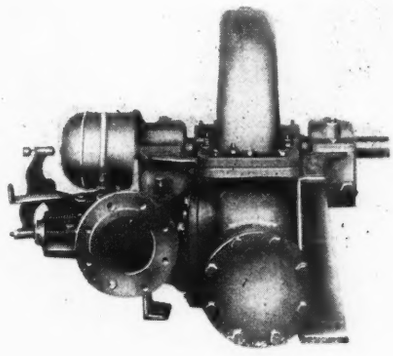
The new instrument, which is designated Duragage, is made in sizes from 4½ to 16 in. for all pressures up to 5,000 lb. and in certain sizes for pressures up to 10,000 lb. It is available in wall-mounted, flush-mounted, and flush-mounted illuminated cases for gage boards.



Duragage with special steel movement

Small Steam Turbine for Auxiliary Drive

A RECENT ADDITION to the line of small mechanical-drive steam turbines put out by the General Electric Company, Schenectady, N. Y., is the Type D58, suitable for driving fans, pumps and similar industrial equipment. The new turbine is designed for operation at steam pressures up to 250 lb. and speeds between 1,200 and 4,000 r.p.m., with capacities up to approximately 250 horsepower.

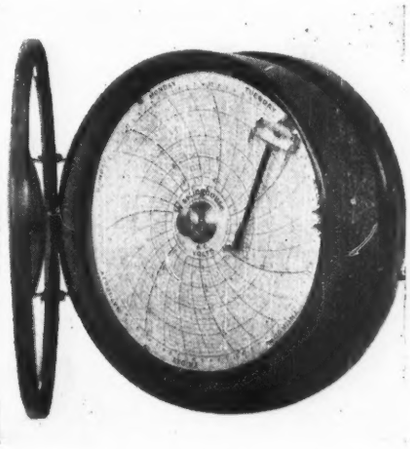


Type D58 mechanical-drive steam turbine

By limiting the range of conditions under which this turbine will be expected to operate, it has been possible to decrease the length and width, making it a compact unit with a considerable saving in weight. The turbine is supported at the center line to permit expansion without affecting the shaft alignment. It is equipped with speed-regulating and emergency governors and is fitted with carbon shaft packing. The pipe connections are made to the lower half of the casing.

Recording Instruments for Switchboard and Portable Use

LIGHT-WEIGHT, small-size circular-chart recording instruments, including ammeters and voltmeters suitable for switchboard mounting or as portable instruments, are announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.



Type A circular-chart recording voltmeter

They are designed principally for alternating-current applications, but are also applicable to certain direct-current services. The ammeters are available in sizes ranging from 5 to 50 amp., and give a full-scale reading from zero to the value at which the meter is rated; the voltmeters are made in ratings varying from that which gives a scale of from 90 to 140 volts to that which records a maximum voltage of 550. The instrument uses for the measuring unit a small motor structure in which a laminated rotor is mounted in the field of an electromagnet.

Three kinds of clocks for moving the circular chart are provided: a key-wound, eight-day clock for driving the one-week charts; a key-wound, 36-hr. clock for driving the one-day charts; and a sub-synchronous motor-driven clock. Change gears are available to change synchronous-driven meters to other speeds.

NEWS of the FIELD

New York Commission Proposes Single-Dam 2,200,000-Hp. Project on St. Lawrence

Claims plan will save $70,000,000 and meet cumulative demand by two-step construction

AN ORIGINAL ENGINEERING PLAN for developing, cheaply and safely, approximately 2,200,000 hp. in the International Rapids section of the St. Lawrence River, was presented Jan. 3 in an engineering board report made public by the St. Lawrence Power Development Commission of New York.

Departing in important respects from the many plans offered previously by American and Canadian engineering groups, the commission's engineering board, headed by Lieut. Gen. Edgar Jadwin, retired, former chief of army engineers, recommended a one-dam, "two-step" development at Massena Point, N. Y., which it claims, will cost less than any plan heretofore considered, will produce more power, can be constructed in less time, will flood a minimum of land, will eliminate the more serious hazards of construction by building power houses and spillway on what is now dry land and will meet Canadian objections to the single dam.

TOTAL COST for the power development is estimated at $171,547,000, or $70,000,000 less than the proposed double-stage plan. This includes the expense of all necessary construction for power (a very large part of which is likewise useful for improved navigation), and covers the cost of arranging the work so that all future navigational requirements may be completed later. It includes also interest during construction. This leaves only $50,499,000 as the cost of additional works to complete a deep waterway in the International section.

The recommended plant is designed to be built in two steps. The first, which would develop 600,000 hp. would cost $79,935,000 or $133.22 per horsepower installed. The second, to develop an additional 1,600,000 hp., would cost another $91,612,000, bringing the average construction cost per installed horsepower down to $77.97. It is estimated that such a development could be producing power in five or six years from the beginning of construction.

In preparing this plan the engineering board had as background numerous studies made over a long period by public and private groups, of which the most important was that of the Joint International group published in 1926.

In this report, the American engineers recommended a single dam at the foot of Barnhart Island, which installed capacity of 2,326,000 hp., estimated to cost $213,000,000, exclusive of work solely for navigation. The Canadians recommended two dams, one at Ogden Island for 406,490 hp., and one at Barnhart Island for 1,808,600 hp.—a total of 2,215,000 installed horsepower at an estimated cost of $231,129,000, exclusive of works solely for navigation. The Canadian plan involved an additional expenditure for navigation of $33,431,000 as compared with $22,000,000 under the American plan.

PER HORSEPOWER cost of the 1926 one-dam plan was $91.57 and that of the complete two-dam plan was $104.35. Thus, the capital cost per horsepower under the new plan is 15 per cent less than under the 1926 one-dam plan and 25 per cent less than under the 1926 two-dam plan.

In 1929 proponents of the two-dam plan reported a modification which would relocate the upper dam at Crysler island. The total construction costs, including all work common to navigation and power, but excluding works solely for navigation, would be $240,554,000 for 2,199,960 hp., or $109.35 per installed horsepower. The construction cost of the initial development would be $131,341,000 for 592,960 hp., or $221.50 per horsepower. Works for navigation alone would total $33,466,000 under this plan.

Advocacy of a two-stage development has been based primarily upon the idea of building one dam, disposing of its power, and making it self-supporting while the second dam was being built. This would cut the interest charges during construction, enable the project to begin earning returns more quickly, and give opportunity for temporary partial development, if it seemed difficult to sell the entire potential output immediately.

The Engineering Board has met this objective by what it describes as a "two-step plan," by which there would be only one dam, but that dam could be built in two steps. The first step, costing $79,935,000 and developing 600,000 hp., would be attained by building the dam to a height that would give 50 ft. of head for the 190,000 cu.ft. of water expected to flow over it per second.

When this power was sold, and it seemed economically desirable to complete the development, the dam could be raised 35 ft., at a cost of another $91,612,000 and an additional 1,600,000 hp. of generating equipment would be added. This would not only cut the per horsepower cost of the initial development from $221.50 to $133 a decrease of 40 per cent but would result in 29 per cent cheaper power on the ultimate development.

File Plea to Reconsider Commission Nominations

A MOTION to reconsider the action of the Senate in confirming the nominations of George Otis Smith, Marcel Garsaud and Claude L. Draper, to be members of the newly organized Federal Power Commission, was filed in the Senate Jan. 5 by Senator Walsh of Montana.

Senator Walsh's motion came as a result of the action of the three commissioners in dismissing from the employ of the commission William V. King, chief accountant, and Charles A. Russell, solicitor of the commission.

As this issue goes to press it is apparent that the vote on the motion will be close, and if passed, its legality will be challenged.

New York Edison Adopts Budget of $48,167,300

A CONSTRUCTION budget of $48,167,300 had been adopted for 1931 by the New York Edison System, it was announced Jan. 4 by Matthew S. Sloan, president of the companies in the system. That sum is apportioned by companies as follows: New York Edison Company, $5,520,100; Brooklyn Edison Company, $20,435,000; the United Electric Light & Power Company, $6,329,200; New York & Queens Electric Light

& Power Company, $15,111,000; the Yonkers Electric Light & Power Company, $772,000.

The budget contains items for generating stations, $11,409,200; substations, $652,600; buildings and yards, $142,000; transmission and distribution, $35,148,200; miscellaneous $815,300. Of the expenditures for generating stations, $426,000 will be for structures and equipment at the East River Station of the New York Edison Company; $1,833,200 for equipment at the Hell Gate Station of the United Electric Light & Power Company, and $8,711,000 for the Hudson Avenue Station of the Brooklyn Edison Company, of which sum $8,290,000 is for two 160,000-kw. turbine-generators to go into service this year and next.

Shoals Conferees Agree On Government Operation

UNEXPECTED CHANGE of position Jan. 7 by one of the House conferees, Representative Wurzbach of Texas, broke the long deadlock that has existed on Muscle Shoals legislation. An agreement was virtually reached when House conferees accepted the Senate proposal to allow the government to construct and operate transmission lines out of the profits of the sale of power. The action of the conferees was regarded as a victory for Senator George W. Norris, Republican, of Nebraska, who has urged the vital necessity of the government controlling not alone the generation of power but also its transmission.

Details relating to the leasing provisions for the fertilizer plants at Muscle Shoals remain to be adjusted by the Senate and House conferees, but it is expected these can be worked out without difficulty. Senator Norris indicated that he expected a complete agreement, now that the power question has been settled in conference.

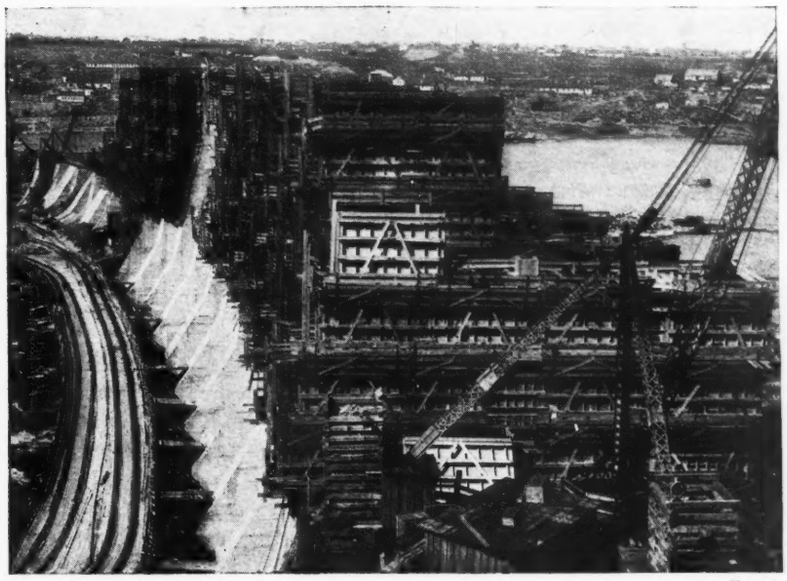
Third International Coal Conference in November

A THIRD INTERNATIONAL CONFERENCE on bituminous coal will be held at the Carnegie Institute of Technology in November, according to a recent announcement made by President Thomas S. Baker, who organized the first two international congresses.

The purpose of the congress will be similar to that of the meetings held in 1926 and 1928: to present for discussion the results of recent studies of coal. Particular attention will be paid to the economics of the new methods and processes that are being evolved.

The program will include papers on carbonization, liquefaction and gasification of coal, by-products of coal and its preparation for the market, pulverized fuels, power plants and heating.

PROGRESS AT DNIEPER RIVER PROJECT



Nesmith

CONSTRUCTION WORK is progressing favorably on the 800,000-hp. hydroelectric project on the Dnieper River in Soviet Russia, according to a recent statement of A. Winter, chief construction engineer of the development, published in the December issue of the *Economic Review of the Soviet Union*. While in 1928-29 180,000 cu.m. of concrete were poured, the amount of concrete poured in 1930 was 500,000 cu.m.

Installation operations are also progressing, he said. All of the under-water part of the power house, for the construction of which tens of thousands of cubic meters of concrete were used, is already completed, and the settings for the nine turbines are ready. Mr. Winter also stated that by December all concrete operations on the construction of the sluices, dam and power house will probably be completed. At the present time the installation of the first four turbines is proceeding satisfactorily.

▼ ▼ ▼

A.S.M.E. Plans Heat-Transfer Division

THE RECENT CONFERENCE held by the American Society of Mechanical Engineers on the question of organizing an air-conditioning division brought out the almost unanimous opinion that what was really needed was a division on heat flow or heat transmission, according to a report published in the A.S.M.E. *News* of Jan. 7.

W. H. Carrier, chairman of the conference, as well as a number of others present strongly objected to a division on air-conditioning, since they doubted that it would be possible to avoid duplication with the American Society of Refrigerating Engineers and the American Society of Heating and Ventilating Engineers.

It was pointed out that a heat-flow division would not only be of great advantage to the society but might also be a joint activity with, or at least have the joint co-operation of the A.S.R.E., A.S.H.V.E. and American Institute of Chemical Engineers. A motion was passed asking each of these societies to appoint two representatives to confer with two representatives of the A.S.M.E. on the advisability of forming such a division to deal with the more technical aspects of heat transfer.

News of Canada

New boiler for Edmonton plant—Progress at Bridge River—Vancouver steam station completed

THE CITY COUNCIL of Edmonton, Alberta, has approved an expenditure of approximately $450,000 for new boiler equipment and an extension to the municipal steam-electric generating plant. In doing so the council took the first step in carrying out a $2,000,000 development project. Plans will be prepared at once and tenders called shortly for the building and boiler installation to be carried out in 1931. The program proposed for 1932 and 1933 contemplates the expenditure of $1,445,000, including $410,000 for a new 15,000-kw. generator.

The city has an interchange-of-power agreement with the Calgary Power Company by which hydro-electric energy is now available at certain seasons from that company's water-power plants on the Bow River. The report of Power Superintendent W. J. Cunningham to the City Council stated that the use of hydro-electric power in Edmonton to supply a portion of the

demand is incidental and should not be allowed to interfere with the addition of equipment for the steam plant. Edmonton is therefore planning to go ahead at once with the power house program. The largest items in the expenditure for 1931 are $120,000 for building costs and $175,000 for boiler and superheater equipment.

At Bridge River, site of the 600,000-hp. hydro-electric project now being undertaken by the British Columbia Power Corporation, activity is still centered on lining the 2½-mile tunnel which has been bored through Mission Mountain, the watershed between Bridge River and Seton Lake. The work of lining the bore is proceeding at the rate of 50 ft. a day, and all the concrete is being mixed inside the tunnel.

Adding 6,700 hp. to the capacity of the British Columbia Electric Railway Company's steam power plant at Vancouver, the sixth unit has been completed and put into service. Costing approximately $181,000, the new equipment forms the largest steam unit in the province of British Columbia, being fed by a boiler of 11,170 sq.ft., and brings the generating capacity of the steam plant up to 23,500 hp. The total capacity of the B. C. Electric mainland system, including the five hydro plants and the steam plant, is now 225,550 hp.

The function of the steam plant is to serve as an emergency source of power in the event of interruption to transmission lines which would cut off the supply from one of the water-power plants or in case of other mishap.

Policies Suggested to Relieve Unemployment

Distribution of an outline of suggested policies and practices for industries during reduced employment and operation was begun Jan. 5 through several hundred trade associations to approximately 65,000 industrial executives throughout the country. The outline was prepared by the President's Emergency Committee for Employment. Based on a study of steps taken by hundreds of companies to meet the present unemployment emergency, the suggestions are compiled in a pamphlet designed to make available a knowledge of these measures to large and small companies alike.

The suggestions deal with methods of spreading employment and of increasing the amount of work available in order to maintain working forces at normal. They also take up procedures to minimize the effects of necessary lay-offs on working forces as a whole, listing some methods to assist laid-off employees and summarizing permanent policies for stabilizing earnings and employment.

The methods of spreading employment include: Reduced weekly schedules through the five-, four-, or three-day week; reduced daily schedule through the seven-, eight-, or six-hour day; shorter shifts in continuous operation, such as four or six shifts a day; alteration of shifts or individuals on the same job, and rotation of days off.

Permanent policies for efforts to stabilize earnings and employment discussed in the pamphlet include: Forecasting and planning production, broader training of new employees to enable workers to work in various departments, standardization of products to facilitate forecasting demand, guaranteeing employment, making the work-day or work-week elastic, and experiments with unemployment insurance.

COMING CONVENTIONS

American Society of Mechanical Engineers. National Fuels Meeting in Chicago, Ill., Feb. 10-13. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-18. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Annual meeting at the Mayflower Hotel, Washington, D. C., Jan. 15-17. Secretary, L. W. Wallace, 26 Jackson Pl., N.W., Washington, D. C.

American Institute of Electrical Engineers. Annual Winter convention in New York City, Jan. 26-30. District meeting in Pittsburgh, Pa., March 9-13. District meeting in Rochester, N. Y., May 6-10. Annual summer convention in Asheville, N. C., June 22-26. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at the William Penn Hotel, Pittsburgh, Pa., Jan. 26-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Engineering Institute of Canada. Annual meeting at the Windsor Hotel, Montreal, Que., Feb. 4-6. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.
Machinists Building, Washington,

National Marine Engineers' Beneficial Association. Annual convention at the Lee House Hotel, Washington, D. C., Feb. 9-15. Secretary-treasurer, Albert L. Jones, 313 D. C.

Personals

William R. Webster, vice-president and director of the Bridgeport Brass Company, has been named chairman of the A.S.M.E. Research Committee for the coming year. Mr. Webster has been an active member of this committee for the past four years. His colleagues on the committee are W. H. Fulweiler, chemical engineer of the United Gas Improvement Company; Alex D. Bailey, superintendent of generating stations of the Commonwealth Edison Company, and A. A. Potter, dean of the Schools of Engineering at Purdue University.

Byron E. White, formerly general engineer of the Utica Gas & Electric Company, is now division engineer of the Central Division of the Niagara Hudson Power Corporation's system.

Melvin D. Engel, assistant to the superintendent of the station engineering department of the Edison Electric Illuminating Company of Boston, was elected chairman of the A.S.M.E. Sectional Committee on the Standardization of Pressure and Vacuum Gages at a recent organization meeting of the committee. Arnold W. Lenderoth, of the Crosby Steam Gage & Valve Company, was elected secretary.

Frederick F. Brand has been appointed managing engineer of the power transformer department of the General Electric Company at Pittsfield, Mass., succeeding F. W. Peek, Jr., who was recently appointed chief engineer of the Pittsfield Works of the company.

B. W. Creim, electrical engineer of the Modesto Irrigation District, has been made temporary chairman of the recently organized Publicly Owned Gas and Electric Utility Association of California. This association was formed to promote the interests and welfare of publicly owned gas and electric utilities in California.

Obituary

Allen Hubbard, member of the engineering firm of Hollis French and Allen Hubbard, Boston, Mass., died suddenly on Dec. 14. Mr. Hubbard graduated from Yale University in 1883. After fifteen years of practical experience, first with the H. B. Smith Company and later with Albert B. Franklin of Boston, one of the pioneers of the heating industry, he entered into partnership with Hollis French and established the firm which has been responsible for the design and construction of the mechanical, electrical and power equipment of a large number of the most important industrial plants, power plants and buildings in New England. Mr. Hubbard was a member of the American Society of Mechanical Engineers, American Society of Heating and Ventilating Engineers, American Institute of Consulting Engineers.

Business Notes

C. H. Wheeler Manufacturing Company, Philadelphia, Pa., announces that P. A. Thompson has recently taken charge of its heat transfer equipment division and will be located at the main office in Philadelphia. Announcement is also made that F. A. Faville has joined the company as manager of its Chicago office, located at 1122 Marquette Building, Dearborn and Adams Sts., Chicago, Ill.

Kennedy Valve Manufacturing Company, Elmira, N. Y., announces the appointment of John J. Foy as its southern California representative, with headquarters at 210 Transportation Building, Los Angeles, Calif.

Union Carbide & Carbon Corporation, New York City, announces that its subsidiaries whose products are used mainly for oxy-acetylene welding and cutting are now marketing those products through the Linde Air Products Company, making it possible to secure through this one company Linde oxygen, Union carbide, Prest-O-Lite dissolved acetylene, and Oxweld, Prest-O-Weld and Purox apparatus and supplies.

E. R. Little Company, consulting and designing engineers of Detroit, Mich., announces the removal of its office to 1805 Ford Building.

Southwestern Engineering Corporation, Los Angeles, Calif., announces that its general offices have been moved to its manufacturing plant at 4800 Santa Fe Avenue.

The Hays Corporation, Michigan City, Ind., has begun construction of a new steel and brick foundry building adjoining its present factory to provide an additional 6,000 sq.ft. of space for the manufacture of scientific instruments.

How's Business?

Things are pointed upward as the new year begins. Business is getting back to the job and starting out vigorously to test the possibilities of improvement. Workers are being recalled after shutdowns for holidays or inventory-taking. Steel activity has rebounded sharply to the end of November level, with improved demand. Automobile production continues the unusual rise that began in December. Building contracts started the year at an encouraging level. Most other indicators have ceased to decline. Our index has moved almost horizontally for four weeks at nearly 77 per cent of normal, and it looks more like the bottom than anything that this depression has so far exposed.—*The Business Week*, Jan. 14.

WITH THE SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Meeting in Room 502, Engineering Societies Building on Jan. 20 at 8 p.m. Subjects: "Utilization of Oil Fuel for Boiler Firing," by N. E. Lewis, Babcock & Wilcox Company, and "Combined Burners for Firing Waste Fuel," by R. C. Vroom, Peabody Engineering Corporation. Joint meeting with the American Welding Society in the Westinghouse Lighting Institute Auditorium, Grand Central Palace on Jan. 22 at 8 p.m. Subject: Discussion on proposed specifications for fusion welding of unfired pressure vessels to be led by C. W. Obert, Union Carbide & Carbon Company.

A.S.M.E., Washington Section. Meeting at the Cosmos Club on Jan. 22 at 8 p.m. Subject: "Engineering and Its Relation to the Interstate Commerce Commission," by Commissioner Frank McManamy.

A.I.E.E., Boston Section. Meeting in Walker Memorial Building, M.I.T., on Jan. 13 at 6:30 p.m. Subject: "Possible Application of D.C. Transmission," by H. R. Summerhays, General Electric Company.

New England Waterworks Association. Meeting at the Hotel Brunswick, Boston, Mass., on Jan. 14 at 1 p.m. Subject: "Water Hammer in Pipe Lines, Its Causes, Manner of Action and Effects," by H. K. Barrows, M.I.T.

Plant Engineers' Club. Meeting at the University Club, Boston, Mass., on Jan. 21 at 6:30 p.m. Subject: "Purchased Power," by S. D. Fitzsimmons, Narragansett Electric Light Company.

Trade Catalogs

General Equipment—McGraw-Hill Catalog and Directory Company, 475 Tenth Ave., New York City, has recently issued the 1931 edition of "Electrical Engineering Catalogs," a collection of manufacturers' catalogs of equipment and supplies used in the generation, transmission and utilization of electric power. Clothbound and profusely illustrated, the book contains 622 pages, including an index of products, directory of manufacturers and tabulated buying data. Price is $15 a copy.

Furnace Walls—Catalog No. 30, covering Economy air-cooled furnace walls, has just been issued by the Furnace Economy Company, 407 South Dearborn St., Chicago, Ill. With the aid of numerous illustrations, charts and blue prints, this catalog presents comprehensive data on the theory, design and construction of these walls.

Pumps—Worthington Pump and Machinery Corporation, Harrison, N. J., has recently issued two new publications on pumps. Bulletin No. D-423-B1 describes vertical triplex power pumps, and Bulletin No. D-450-B1A covers deep-well pumps. Both publications are fully illustrated and contain much information on the construction and applications of these units.

Electric Motors—Bulletin No. 207 of the Reliance Electric & Engineering Company, 1057 Ivanhoe Road, Cleveland, Ohio, illustrates and describes the constructional features and installation of Type T heavy-duty Reliance planer motors for reversing service.

Gears—Link-Belt Company, Philadelphia, Pa., has just issued a new 16-page book, No. 1274, descriptive of its recently announced P.I.V. gear—an all-metal variable-speed transmission. This "positive, infinitely variable" gear is illustrated and fully described in the book, with many industrial applications.

Fuel Prices

FUEL OIL

New York—Jan. 8, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, contract, 6c. per gal.

St. Louis—Jan. 6, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.389 per bbl., or 42 gal.; 26@28 deg., $1.48 per bbl.; 28@30 deg., $1.639 per bbl.; 30@32 deg., $1.739 per bbl.; 32@36 deg., gas oil, 4.026c.@4.276c. per gal.; 38@40 deg., distillate, 4.776c. per gal.

Pittsburgh—Dec. 31, f.o.b. local refinery, 34@36 deg., fuel oil, 3.37½c.@3.5c. per gal.; 36@40 deg., 3.37½c.@3.5c.

Philadelphia—Jan. 2, industrial use, No. 4, light, $1.31 per bbl.; No. 5, medium, $1.22; No. 6, heavy, (Bunker C) $1.10.

Cincinnati — Dec. 30, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Dec. 22, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 95c. per bbl.; 30@32 deg., $1.00 per bbl.

Boston—Jan. 5, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.9c. per gal.; 28@32 deg., 4.8c. per gal.

Dallas—Jan. 3, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, hr.gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	.75 @ 1.35
Harlan, Ky., slack	Chicago	.60 @ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.35 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.85
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	1.00 @ 1.35
W. Ky., slack	Louisville	.40 @ .60
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	1.75 @ 2.25
Smokeless, slack	Cincinnati	.75 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.40 @ .75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Brawley—Mulberry School District, H. Cron, Clk. will soon award contract for the construction of a 110 v., 1,500 kw. automatic lighting plant.

Kan., Kansas City—City awarded steel contract for superstructure of a power plant to Kansas City Structural Steel Co., 21st St. and Metropolitan Ave. Esimated cost $69,000.

La., New Orleans—Sewage & Water Board, G. G. Earl, Gen. Supt., received lowest bid for Cont. 118 D extension to drainage pumping station 7 at Florida Ave. and Orleans St. from Gervais Favrot, Baltimore Bldg., $92,979.

Me., Bingham—Central Maine Power Co., Bingham, subsidiary of National Electric Power Co., 57 William St., New York, N. Y., plans the construction of second and third units of hydro-electric plant here. Estimated cost to exceed $1,000,000. First unit completed.

Md., Baltimore — Mayor and City Council, Municipal Bldg., received lowest bid for the construction of an automatic pumping station from DeCou & Chidlaw, 857 North Eutaw St.

Mass., Wellesley—Water and Municipal Light Commissioners, W. H. Blood, Jr., Taylor Block, awarded contract for addition to sub-station to Hill & Delaney, 108 Massachusetts Ave., Boston. Estimated cost $40,000.

Minn., Duluth—Duluth Steam Corp., P. J. Dwyer, Gen. Mgr., will receive bids late in January for the construction of a central heating plant, including four 800 hp. boilers. Estimated cost $1,250,000.

N. H., Dover — Public Service Co. of New Hampshire, A. R. Schiller, V. Pres., Manchester, is having plans prepared for the construction of a power sub-station here; also plans private dock at Portsmouth for new floating power plant "Jacona" now under construction. Latter will be done by owner's forces. Estimated cost $165,000 and $190,000 respectively. Private plans.

N. J., Jersey City—Mongiello Bros., 625 Communipaw Ave., will receive bids about Mar. 1 for the construction of a 100 x 100 ft. ice plant including ice making machines, tank, storage rooms, etc. Estimated cost $50,000. C. H. Ziegler, 26 Journal Sq., is architect.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of a 2 story, 35 x 75 ft. gas manufacturing plant on Duffield Ave. here to United Engineers & Constructors Inc., 80 Park Pl., Newark. Estimated cost $50,000.

N. J., Newark—John H. and W. C. Ely, 605 Broad St., Archts., will receive bids about Apr. 1 for the construction of a 5 story hospital, nurses home and power house for St. Barnabas Hospital, 685 High St. Estimated cost $1,500,000.

N. Y., Bedford Hills—Dept. of Correction, State Capitol, Albany, will receive bids about Feb. 1 for a power plant, additional boiler equipment with stokers, new laundry building, cold storage plant, etc., at New York State Reformatory for Women here. Estimated cost to exceed $40,000.

N. Y., New Windsor (mail Newburgh) — Hudson Gas & Electric Corp., 50 Market St., Poughkeepsie, has been granted permit to construct a gas plant here, also transmission line from its plant at Newburgh through the town of New Windsor.

N. Y., New York — Dept. of Sanitation, Municipal Bldg., will receive bids about Feb. 15 for the construction of a sewage disposal plant including 145 x 345 ft. pump and blower house, 40 x 94 ft. heating plant, four 21 x 34 ft. pumping stations and one 123 x 805 ft. pumping station, etc., on Wards Island. Estimated total cost $6,680,000. Fuller & McClintock, 170 Broadway, are engineers.

N. Y., Schenectady—General Electric Co., B. L. DeLack, Mgr., River Rd., plans the construction of a power generating development to include a large mercury vapor turbine and tunnel 3/5 of a mile long, between old and new River Rd. Estimated cost $4,000,000. Plant will be leased and operated by New York Power & Light Corp., 511 State St.

N. Y., Yonkers—Yonkers Electric Light & Power Co., 45 South Broadway, plans the construction of sub-stations, also transmission and distribution lines, equipment and miscellaneous work. Estimated total cost $772,000. Work will be done by day labor and separate contracts.

O., Cleveland—Bd. of Education, F. G. Hogen, Dir., will receive bids until Jan. 19 for the construction of a 3 story high school including steam heating and ventilation systems, boilers, elevators, etc., on East 74th St. Estimated cost $1,000,000. G. M. Hopkinson, Auditorium Garage Bldg., is architect.

O., Cleveland—City is having preliminary plans prepared for the construction of a waterworks system including pumping station, filtration plant, reservoir, etc. Estimated cost $600,000. L. A. Quayle, City Hall, is engineer.

Tex., Beaumont—O. P. Sawyer, Grand and Long Sts., plans resort development including the installation of hydraulic turbine and electric light plant, etc. A. Babin, Perlstein Bldg., is engineer.

Tex., Corpus Christi—Colonial Beach Club, c/o R. L. Harrell and L. Lusk, plan the construction of a complete waterworks system to include pumping unit, distribution mains, etc. at Junction of Padre and Mustang Islands near here to connect with club buildings and cottage inns; also power and lighting systems with dynamo unit and power for other electrically operated mechanisms.

Tex., San Antonio—T. Newton, Court House and T. Donoghue, 119 Daniel St., plan the construction of a 30 ton ice and cold storage plant. Estimated cost $40,000. Private plans.

Tex., Schertz—U. S. Government, A. W. Parker Constructing Quartermaster, will receive bids until Jan. 16 for the construction of an electric sub-station and gas meter house at Randolph Field. Private plans.

Tex., Taylor—City plans the construction of a waterworks system including reservoir, 75 ft. high, pumping unit, mains, etc. Estimated cost $125,000. Private plans.

Tex., Waco—U. S. Veterans Bureau, War Dept., Arlington Bldg., Washington, D. C., will soon receive bids for the construction of a group of hospital buildings including nurses' home, heating plant, etc., here. Estimated cost $1,200,000.

Tex., Wichita Falls—City plans an election Jan. 20th to vote $1,000,000 bonds for waterworks improvements including reservoir, pumping unit, distribution lines, etc. Montgomery & Ward, 544 Harvey-Snider Bldg., are engineers.

Tex., Yoakum—City will receive bids about Feb. 1 for the construction of a waterworks system including large pumping unit, mains, etc. Estimated cost $250,000. Montgomery & Ward, 544 Harvey-Snider Bldg., are engineers.

Wash., Seattle—Bd. of Public Works, G. W. Roberge, Secy., will soon receive bids for the superstructure of power house in connection with Diablo hydro-electric development on the Skagit River, $500,000, will also receive bids until Jan. 16 for transmission line conductor and accessories to connect Diablo power plant with sub-station in Seattle. It will be approximately 125 mi. long and designed to carry 150,000 kva. at 220 kv., 60 cycle, 3 ph. $800,000.

Wash., Spokane—Spokane & Eastern Trust Co., J. L. Campbell, Secy., 601 Riverside St., affiliated with Northwest Ban-corporation, 6th St. and Marquette Ave., Minneapolis, Minn., awarded contract for an 8 story bank and office building at Howard and Riverside Sts. to Phelps-Drake Co., 711 Metropolitan Life Bldg., Minneapolis. Estimated cost $500,000. Steam heating system, etc. will be installed.

Wis., Milwaukee—Sewerage Commission, will receive bids until Jan. 16 for the construction of a return sludge pump house and pipe tunnel at sewage disposal plant, Jones Island. Estimated cost $50,000. J. L. Ferebee, is chief engineer.

Equipment Wanted

Boiler and Engine — Dorchester, Mass. — Quality Laundry, 9 Columbia Pl., plans to purchase one Massachusetts Standard 100 hp. return tube boiler and one 45 to 50 hp. steam engine.

Engine and Generator — Norwich, Conn. — Norwich State Hospital, plans to purchase engine and generator for power plant. Estimated cost $25,000.

Pumps—Modesto, Calif.—Modesto Irrigation Dist., plans the installation of pumps, etc., for proposed waterworks system. $20,000.

Pumps, etc.—Beverly Hills, Calif.—City Council will receive bids until Jan. 27 for furnishing and installing booster pumping equipment and deep well turbine pump, etc. for proposed waterworks.

Sub-Station Equipment—San Antonio, Tex.—San Antonio Public Service Co., 201 North St. Mary's St., plans for 1931 considerable changes in equipment for power sub-stations in San Antonio District. $350,000.

Transformers—Chicago, Ill.—Dept. of Gas & Electricity, M. J. Kennedy, Comr., will receive bids until Jan. 19 for pole type series transformers for 1,000 c.p. lamps, municipal electric street lighting system for use during 1931.

Turbine—Independence, Mo.—City plans to purchase a steam turbine for present power plant. Estimated cost $25,000.

Industrial Projects

Ariz., Kingman—Glenidick Mines Corp., c/o H. Derer, Mgr., plans the construction of a 50 ton cyanide mill.

Calif., Olive—Olive Heights Citrus Assn., B. H. Cole, Mgr., is having plans prepared for the construction of a pre-cooling plant. Estimated cost $75,000. Private plans.

Calif., Stockton — Schmidt Lithograph Co., Second and Bryant Sts., San Francisco, plans the construction of a plant for the manufacture of paper products, here. Estimated cost to exceed $150,000.

D. C., Washington—O. J. Maigne Co., 356 Pearl St., New York, N. Y., will receive bids about July 1 for the construction of a 3 story plant for the manufacture of printers' rolls at 2218 Georgia Ave. here. Estimated cost to exceed $40,000. Dodge & Morrison, 160 Pearl St., New York, N. Y., are architects.

Ill., Galesburg—Rowe Mfg. Co., will build a 1 story, 112 x 126 ft. factory including 30 x 30 ft. power and heating plant, etc. on West Third St. Work will be done by owners' forces.

Md., Baltimore—H. C. Weiskittel Co., c/o E. Eyring & Sons Co., Third St. and Fait Ave., Contrs., awarded contract for the construction of a pipe foundry, pattern and machine shops, garage and gas range factory at Philadelphia Rd. and Monument St.

Mass., Fitchburg — Crocker-Burbank & Co., 545 Westminster St., awarded masonry contract for the construction of a 2 story, 60 x 85 ft. power plant on Westminster St. to Proffitt & White, 1137 Main St., Leominster. Estimated cost $75,000.

N. J., Old Bridge—Anheuser-Busch, Inc., c/o A. A. Busch, Pres., 721 Pestalozzi St., St. Louis, Mo., awarded contract for the construction of a yeast plant, 100,000 lb. daily capacity, to include garage, machine shop, power plant, etc. here to Stone & Webster Engineering Corp., 120 Broadway, New York, N. Y. Estimated cost $2,000,000.

O., Cleveland—Otis Steel Co., 3341 Jennings Rd., awarded contract for construction, equipment and installation of a continuous strip steel mill to United Engineerig & Foundry Co., Farmers Bldg., Pittsburgh, Pa. Estimated cost $1,800,000.

O., Cleveland—Yoder Co., H. O. Yoder, Secy. and Treas., 5500 Walworth Ave., machinery manufacturers awarded contract for a 1 story, 97 x 400 ft. factory on Walworth Ave. to Gillmore-Carmichael-Olson Co., 4300 Euclid Ave. Estimated cost $200,000.

O., Middletown—Lockwood, Greene & Co., Hanna Bldg., Cleveland, Archts., will soon award contract for the construction of a 1 story paper bag factory here for Raymond Paper Co., Middletown. Estimated cost $150,000.

O., Toledo—Libby Glass Co., Ash St. and Wheeling Lake E. R., awarded contract for the design and construction of a factory including new warehouse, engine room, machine shop, boiler house, etc. to H. K. Ferguson Co., Hanna Bldg., Cleveland. Estimated cost $600,000.

Pa., Baden—Pennsylvania R.R., Broad St. Station, Philadelphia, will soon receive bids on general contract and mechanical equipment for rail river terminal to be used mainly in transportation of coal, on Ohio River near east end of Conway yards. Estimated cost $350,000. T. J. Skillman, Philadelphia, is chief engineer.

Pa., Philadelphia—Barrett & Co., 40 Rector St., New York, N. Y., will receive bids until Jan. 15 for the construction of a plant for the manufacture of coal tar products at 36th St. and Grays Ferry Rd. Private plans.

Vt., Burlington—Vermont Fruit Co., B. J. Fayette, is having plans prepared for the construction of a plant including refrigeration plant at Battery and Maple Sts. Estimated cost $100,000. Private plans.

Ont., Kingston — Everlastik Corp., Webster and Spencer Aves., Chelsea, Mass., webbing manufacturers, plans the construction of a plant here. Estimated cost to exceed $40,000.

Russia, Moscow—Union Soviet Socialist Republic, c/o Amtorg Corp., 261 5th Ave., New York, N. Y., will build a gas manufacturing plant and gas pipe lines at Moscow and other locations. Estimated cost to exceed $5,000,000. Lucas & Luick, 231 South La Salle St., Chicago, Ill., are engineers. Work will be done by day labor and separate contracts.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

ELECTRICAL supplies entered the new year with a stronger tone prevailing in prices, despite December's fluctuations in copper wire quotations. Among the power-plant supplies, there was an advance in one and decreases in three, during the last month. Cement is up 13c. per barrel, to $2.23, delivered in New York. Red lead (dry. dropped ½c. per lb., to 13½c., f.o.b. New York. Declines also occurred in linseed oil and highest grade babbitt.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft.		$0.65
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50–10%

Air—Best Grade, Net

¾-in., per ft.	3-ply....$0.30	4 ply....$0.36

Steam—Discounts from List

First grade.... 50%	Second grade..... 50–5%	Third grade.... 60–5%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade....60%	Second grade....60-5%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—Cut lacing, best quality, 30-10%; 2nd quality, 50%. Lace leather sides, best, 12-17 sq.ft., 55c. per sq.ft.; 2nd, 48c., net. Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¾ in.	$0.90
Asbestos for high-pressure steam, ¾ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.23 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ½-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 400 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	10.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.14½
New York (100 lb. bales)	.14
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.094	$0.101	$0.098

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o b., New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.75

*This price is for full kegs; broken-kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	45.00
Commercial genuine, intermediate grade	34.00
Anti-friction metal, general service	30.00
No. 4 babbitt, f. o. b.	10.00

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	55%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..	$0.05 per cut	3-in.....	$0.09 per cut
2¼ and 2½ in.....	.06 per cut	3¼ to 4 in..	.10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$23.37	$38.24	$66.00	$86.75
No. 12 solid....	38.02	50.52	76.00	104.00
No. 10 solid....	52.10	66.22	95.00	124.00
No. 8 stranded..	85.34	105.22	133.00	185.00
No. 6 stranded..	123.58	148.81	180.00	253.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
¼	$60.89	$8.31	$4.79	$55.67	$7.14	$4.36
⅜	77.61	10.94	6.85	70.53	9.41	6.24
1	111.26	16.35	8.94	100.80	14.07	8.14
1¼	150.53	22.47	12.59	136.38	19.71	11.54
1½	180.00	30.05	15.59	163.08	26.35	14.29
2	242.20	54.69	20.87	219.43	47.92	19.15
2½	382.95	90.49	29.81	346.95	79.41	27.34
3	500.80	233.74	44.70	453.72	204.21	41.01
3½	630.74	511.83	59.92	574.14	446.60	55.00
4	769.61	591.84	74.69	702.53	516.46	68.53
4½	896.51	892.12	111.40	818.37	777.99	102.16
5	1045.06	1240.73	122.91	953.99	1082.29	112.75
6	1355.64	1547.71	177.72	1237.49	1350.80	162.95

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L	$0.12	D. P. D. B	$0.31
D. P. M. L	.16	T. P. S. B	.35
T. P. M. L	.27	T. P. D. B	.47
D. P. S. B	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L	$0.27	$0.70	$1.75
T. P. M. L	.40	1.00	2.30
D. P. S. B	.35	.87	.....
T. P. S. B	.67	1.50	.....
D. P. D. B	.65	1.75	.....
T. P. D. B	1.12	3.00	.....
T. P. to D. P. D. B	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$15.00
No. 16 cotton reinforced heavy		19.00
No. 18 cotton reinforced light		12.00
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		13.00
No. 16 cotton Canvasite cord		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List Each	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1
REFILLS—				
1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	25%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	56%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.50
0–30 ampere, less than standard package, per 100	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.06

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.75	$6.50	$7.10	$13.20
12	6.90	8.00	9.00	17.00
10	8.45	10.40	11.80	22.50
8	13.00	15.00	17.15	32.00
6	.....	.....	23.00	.....
4	.....	.....	34.00	.....
2	.....	.....	47.00	.....
1	.....	.....	70.00	.....
0	.....	.....	83.00	.....
00	.....	.....	95.00	.....
000	.....	.....	117.00	.....
0000	.....	.....	142.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In or Pendant Cap Key	½ In or Pendant Cap Keyless	½ In or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb
Wire solder, in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%